THE GLASS INDUSTRY

VOLUME 19, NUMBER 5, MAY, 1938

# FORTIETH ANNUAL A. C. S. MEETING

The annual meeting of the American Ceramic Society held at New Orleans the week of March 27, proved one of the most colorful of any in the forty years' history of the Society. As early as Sunday morning, when the special from the East emptied 125 delegates into the lobby of the Roosevelt, and continuing all through Monday, trains and automobiles kept feeding a constant stream of ceramists into the Crescent City. And if the Society failed, a year ago, to make New York City ceramic conscious, it definitely achieved the objective at New Orleans.

The formal programs followed their customary pattern; it is in the line of social activity that the New Orleans meeting will be remembered as individual and outstanding. The beauty of the city itself, the quaint French Quarter, the restaurants and their incomparable cuisines, the ride on the Mississippi—and what city is there that could attract a crowd of hard-boiled ceramists to its cemeteries!

The Glass Division Meeting was one of the best ever, both in attendance and interest. Accounting for 10 per cent of the A. C. S. membership, it had 11 per cent of the convention registration. But it was well that glass technologists, like their pyrosilicate brethren the ceramists, are accustomed to high-temperature operation and to the noise of machinery, because the thermometer stood close to 90° and the electric fans played annoying overtones to all the discussions.

New officers elected by the Division to serve for the ensuing year are: Chairman, L. C. Roche, Maryland Glass Corporation; first vice-chairman, Nelson W. Taylor, Pennsylvania State College; second vice-chairman, W. Ronald Lester, Maryland Glass Corporation; secretary, Samuel R. Scholes, Alfred University; trustee, Donald E. Sharp, Hartford-Empire Company. Committees: Nomination A, George W. Morey, Geophysical Laboratory; Nomination B, James Bailey, Hartford-Empire Company; Editorial, G. E. F. Lundell, Bureau of Standards (chairman); B. E. Warren, Massachusetts Institute of Technology; James Bailey; Papers and Program, Nelson W. Taylor, W. Ronald Lester; Membership, John T. Ogden, THE GLASS INDUSTRY; Standards, G. W. Morey; Rules, A. N. Finn, Bureau of Standards; Councillor, Francis C. Flint, Hazel-Atlas Glass Company.

Chairman Finn called the meeting to order and, in shirt sleeves, the members sat through three afternoons given to the presentation and discussion of an excellent assortment of papers.

Those who watch with apprehension the awe-inspiring astronomical figure that represents our mounting national debt, may be a trifle soothed by the thought that some of the smaller numbers toward the right are added by the cost of preparing a Report on Glass in 1937, under the direction of Professor Silverman. The preparation of this reference volume has been made a W. P. A. project.

An encouraging sign was the willingness of several of the technologists to go off the deep end and propose theory. Warren does this by interpreting X-ray patterns of soda-boron oxide glasses to mean that coordination numbers grow larger as more soda is added, so that each boron atom tends to acquire four instead of three oxygens. Scholes, in a more old-fashioned view, speaks of compounds of soda and boron oxide in such glasses, particularly in the so-called borosilicates. Taylor, not content to have a decrease in viscosity upon rise of temperature remain a simple and unexplained physical fact, wants to relate it to constitution, and to have it the result of dissociation, perhaps in the sense of ions of potassium separating from silicate ions. These gropings toward an explanation of what goes on in vitreous solution reflect dissatisfaction with the view that glasses behave like simple solutions of oxides.

Discussion brought out the fact that these recent expressions of belief as to constitution of glasses differ more in the choice of terms than in ideas.

The moot question of property composition graphs, and indications to be drawn from them as to constitution, was brought up again, this time by Finn. He reported on some simple alkali-silica glasses, and found that density and also expansibility, plotted against composition, should be represented by intersecting straight lines. The breaks, or junctions, point directly to eutectics, if not to compounds.

A neat piece of work on surface tension by maximum bubble pressure, by Bradley of Corning, presented by Littleton, not only adds more data in this interesting field, but confirms the usefulness of the technique developed by Parmelee.

Papers by Taylor, and by Lillie of Corning, on annealing (stress release) indicate that this subject is still subject to various interpretations, which may soon flow together into an accepted theory.

Bureh and Babcock, of Owens-Illinois, reported ingenious experiments proving that colored glasses do cool faster than flint glass, and, therefore, that glass workers have not deceived themselves in finding greater working speeds or higher machine speeds necessary for green or amber glasses. The other color paper, by Weyl of Penn State, condensed material already published in *Sprechsaal*. He gave an explanation of fluorescence, and a still more interesting description of a type of fluorescent glass containing silver, capable of converting the ultra-violet

Rafael

light of gas-discharge tubes into visible light, thus creating an economical light source.

The persistent efforts of Finn to arrive at a method for estimating refracting power of glass from composition have now led him to develop constants for the Gladstone and Dale equation for specific refractivities. The molecular weight and atomic radius of each oxide furnish the necessary data. Perhaps, as the moderns say, the remaining time will no longer be greatly extended.

Lillie was not quite ready to present his data on permanent bends in glass canes. This leaves something to anticipate.

The most entertaining paper of the meeting was presented by Swicker of Hartford-Empire, and it was his first appearance in this role. A series of beautiful colored slides, from color photomicrographs, taught the group much about why is a bad bottle, and also demonstrated the efficacy of the ring-section method of examination. This work is strain finding of the most searching and definite sort.

Another colorful paper set forth by actual specimens how Hamilton and Finn, Bureau of Standards, have succeeded in applying a surface stain to glass after acid treatment, and bringing out gradations of blue tint which are definite indications of relative durability—or do we mean solubility?

Preston's new study course on Mechanical Properties, as well outlined by Roering, will evidently be something to wait for, in print. Unfortunately, a cordial telegram from Preston was all we had of him.

## ABSTRACTS OF PAPERS

**1. Annual Report on Glass.** *By Alexander Silverman, University of Pittsburgh. (Read by S. R. Scholes.)*

As the Works Progress Administration is anxious to promote projects having educational value, Dr. Silverman submitted a proposal to the WPA which involves the creation of a project to prepare a 1937 Annual Report on Glass. The project has been granted to the City of Pittsburgh and Dr. Silverman has been appointed its director.

The organization is to consist of a supervisor, an editor, three translators, two recorders, a clerk and two typists. Part of the personnel has already been appointed or assigned, and while it has considerable background in science, the individuals have practically no knowledge of the glass field and it will be necessary for the director first to train them along these lines.

In preparing this report, the abstracts appearing in the various journals, if adequate, will be recorded in the file; if inadequate, a further search will be made. In addition to the abstracts appearing in the journals, the files of all technical, trade and art journals and books on glass which have appeared during 1937 will be searched.

The headquarters of the group will be the University of Pittsburgh. The University, the Carnegie Library, the Mellon Institute, the Pittsburgh Station of the U. S. Bureau of Mines and the private library of Dr. Silverman will supply the material to be searched.

It is hoped that a comprehensive report regarding the developments in the glass field during 1937 will result.

**2. Physical Properties of $B_2O_3$ Glass.** *By Howard Lillie, Corning Glass Works.*

The physical properties of boric oxide glass are of interest since they show whether a simple inorganic glass exhibits the same characteristics as are generally observed for the more complex commercial glasses. In addition, it is hoped that a knowledge of such properties will be useful in fundamenatl studies dealing with atomic consituation and its effects. Some use may also be found for the data presented here in connection with the calibration of such equipment as viscometers, pure $B_2O_3$ glass being readily obtainable in any laboratory.

The following is a summary of the newly measured properties now at hand:

| | |
|---|---|
| Softening Point | 339°C |
| Annealing Point | 242°C |
| Strain Point | 220°C |
| Expansion Coefficient (0—170°C) | $1.60 \times 10^{-5}$/°C |
| Electrical Conductivity (300°C) | nil |

Surface Tension: 62 dynes/cm at 400°C increasing almost linearly to 90 dynes/cm at 1200°C.

| | |
|---|---|
| Young's Modulus (room temp.) | 1800 kg/mm² |
| Shear Modulus (room temp.) | 670 kg/mm² |
| Birefringence Constant (room temp.) | 8.87 mμ/cm per kg/mm² |

Viscosity (Representative points)

| | |
|---|---|
| 212°C | $\text{Log}_{10}7 = 14.34$ (Initial) |
| 212 | 15.10 (After 1 week) |
| 400 | 6.32 |
| 600 | 3.48 |
| 800 | 2.51 |
| 1000 | 1.98 |
| 1200 | 1.62 |

Stress Release Rate at Constant Temperature

212°C Annealing Constant "A" = $2.00 \times 10^{-6}$ cm/mu/min. (Initial)

and $1.35 \times 10^{-6}$ (after 1 week)

Viscosity—Stress Release Equation:

$$-\frac{df}{dt} = Mf\,(\zeta - 6.8 \times 10^{-16}) \qquad \zeta = 1/7$$

where the modulus M = 111 kg/mm².

It is concluded that, except for the temperature at which various effects appear, these effects are very similar to those observed in more common commercial glasses.

**3. Expansibility Factors for Boron Oxide Glasses.** *By S. R. Scholes, New York State College of Ceramics at Alfred University.*

In the consideration of the physical properties of glasses as they are affected by the presence of $B_2O_3$ it is a well-known fact that boron oxide has an effect in one direction upon a given physical property when it is added in small amounts up to a certain percentage in relation to the amount of alkali present. Beyond this percentage there is a reversal in the effect. For example, glasses are greatly reduced in expansibility by the addition of small amounts of boron oxide, whereas larger amounts may even cause an increase in this property.

Dr. Scholes offered a possible explanation of this by advancing the theory that the boron oxide, with the alkali, forms a borate which has different physical properties from those of the alkali silicate. Since silica is always greatly in excess of boron oxide in the commercial glasses, the partition of the alkali between silica and boron oxide is always in favor of the former. By assuming that this partition will be somewhat in the proportion

1

2

3

4

5

6

7

8

10

11

12

THE

The
at a
Glas
on t
ward
soci
mari
page
atte
face

1. V
Cine
and
insp
close
"cer

2. 3
cinn
with
arriv

4. D
for
aigni

5. R
mari

6. 7.

8. 9.
low)
first

10.
*Roos*
ister

12.

13.
conv
land,
eye.
with

15.
for l

16.
elect,
— or

17.
Fair
more
is a l

18.
leps

19.

20.

21.

23.
Purdy

24.
Murp
Royal

25.
leans

26.
McAf

27.

## THE CONVENTION STORY IN PICTURES

**The candid camera, ever present these days at all news-making functions, followed the Glass Division from its start at New York, on the "special" as it rolled its way southward, then on through the meeting halls and social functions at New Orleans. This remarkably fine collection of views (see also pages 175 and 178) will recall to all who attended this memorable meeting, scenes and faces they will delight in remembering.**

**1. While the special makes a brief pause at Cincinnati to take on cars from the north and west, President-elect Kelsey and retinue inspect the "uremic special," which was as close as the railroad men could come to "ceramic."**

**2. 3. Mr. and Mrs. F. W. Adams in the Cincinnati depot, and (right) editor Bardrof with publisher Ogden wait for the train's arrival.**

**4. Doc Shively makes an unsuccessful bid for privacy while he is dressing. There is no significance to the sign.**

**5. Roy Blunt and Cy Delgado — smoking marijuana?**

**6. 7. Ceramists in the diner and lounge car.**

**8. 9. Mr. and Mrs. J. Earl Frazier, and (below) Dr. and Mrs. E. W. Tillotson have their first introduction to southland dishes.**

**10. 11. A trainload of guests swamps the *Roosevelt*. It took nearly two hours to register the Sunday morning contingent.**

**12. At the A. C. S. registration desk.**

**13. 14. Waiting for the Glass Division to convene. Donald Sharp and Virgil Mulholland, the former before receiving his black eye. Dr. Littleton in animated conversation with Sam Scholes.**

**15. J. Earl Frazier, waiting for a big order for lehrs.**

**16. Nelson W. Taylor, first vice-chairman elect, deep in the intricacies of glass making — or is it refractories?**

**17. The final day of racing at the celebrated Fair Grounds track, where it was proved that more than one member of the Glass Division is a lover of horse flesh.**

**18. Familiar scenes number xxx: Mint Juleps in the grille of the *Roosevelt*.**

**19. The President's reception.**

**20. Country Club dinner and dance.**

**21. 22. Armand Houze, Jr.; D. D. Schurtz.**

**23. Mrs. J. Earl Frazier, with connoisseurs Purdy and Hettinger.**

**24. W. L. Shearer and Mrs. Gertrude B. Murphy offer salutations from the Patio Royale.**

**25. A. N. Finn and escorts at the New Orleans Country Club.**

**26. Three musketeers: Irwin Zeiller, Keith McAfee and Roy Blunt.**

**27. Ross Purdy attempting a disguise.**

17

18

24

19

20

2

21

23

2

of the concentrations of the two acidic oxides mentioned, and assuming also that the borate which forms is the most acid one; namely, $Na_2O.4B_2O_3$, the composition of a glass may be described as consisting of silica, sodium disilicate, $Na_2O.4B_2O_3$, boron oxide and other oxides that may be present.

On this basis it is possible to take the actual values for physical properties of the glasses represented by these four compounds in pure form as simple glasses, and use these as factors for the estimation of physical properties. By this means a more consistent approach to the estimation or prediction of physical properties of glasses containing boron oxide can be made than by the use of factors hitherto presented, which do not take into acount the change in effect as greater quantities of the oxide are added, nor the possibility of chemical combination.

**4. X-Ray Diffraction Study of Soda-Boric Oxide Glass.** *By B. E. Warren and J. Biscoe, Department of Physics, Massachusetts Institute of Technology.*

Three samples of soda-boric oxide glass having the following molal compositions: 0.114 $Na_2O$, 0.886 $B_2O_3$; 0.225 $Na_2O$, 0.775 $B_2O_3$; 0.333 $Na_2O$, 0.667 $B_2O_3$ were melted in a platinum crucible from which rods about one millimeter in diameter were drawn. Diffraction patterns were made of the glasses in an evacuated camera using Mo K $\alpha$ radiation monochromated by reflection from a rock salt crystal. Intensity values were computed from microphotometer traces of the patterns (Fig. 1).

A Fourier analysis of the intensity curves was then made and distribution curves obtained. The first peak is due to the boron-oxygen separation. The distances are 1.37, 1.42 and 1.48Å. From the peak areas, the numbers of oxygens about a boron were found to be 3.2, 3.7 and 3.9. From these results it was concluded that this continuous change, both in interatomic distance and number of surrounding oxygens, indicates that the borons are partly in triangular and partly in tetrahedral coordination. As the soda content increases, more and more of the borons become tetrahedrally coordinated.

The distribution curves also indicate that there are six oxygens about each sodium at 2.4Å, and from five to six oxygens about each oxygen at 2.4'Å.

These results indicate that the structure of soda-boric oxide glasses corresponds to the following picture: each boron is bonded to either three or four oxygens, the fraction in tetrahedral coordination increasing with increase in soda content. Most of the oxygens are bonded to two borons. The borons and oxygens form a random network and the sodium atoms are randomly distributed in holes in the boron-oxygen network, with each sodium being surrounded by about six oxygens.

It was suggested by Dr. Warren that the boron anomaly (see paper No. 3 by S. R. Scholes) might be explained by the ability of boron to change from triangular to tetrahedral coordination. It was shown that in a soda-boric oxide glass the density is at a maximum when the ratio of $Na_2O$ to $B_2O_3$ is one to one, and that this is just the composition at which all of the borons are in a tetrahedral coordination. If the ratio of $B_2O_3$ to $Na_2O$ is less than one to one, there will be breaks in the tetrahedral network, and the density decreases. When the ratio of $B_2O_3$ to $Na_2O$ is greater than one to one, some

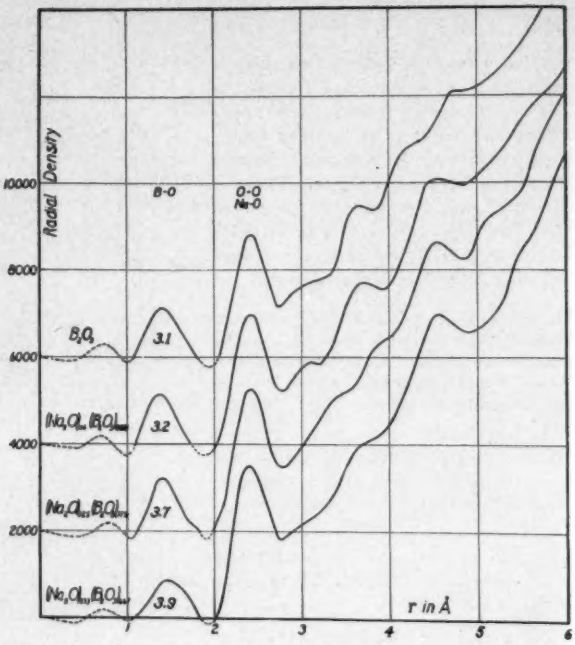



**Fig. 1.**

of the borons will be in triangular coordination and the density again decreases.

**5. Some Linear Relations Between Composition and Density of Binary Glasses.** *By J. C. Young and A. N. Finn, National Bureau of Standards.*

A study of data obtained in the last few years from new glasses and a re-examination of previously reported data indicates that the relation between composition and density of soda-silica, potash-silica and lithia-silica glasses can be more accurately expressed by intersecting straight lines than it can by any single curved line. In addition, these intersections, which represent changes in the rate of change of density, seem to occur at compositions which correspond closely to the eutectic compositions reported in the literature. This observation is particularly true of the density data on the soda-silica glasses and the equilibrium diagrams as determined by Kracek. It also holds for the soda-potash-silica glasses of the three component system. Here the density data in certain ranges of compositions can be represented by plain surfaces intersecting at points corresponding to the eutectic composition in the three component system.

While the points of intersection of the lines differ somewhat from those previously reported, the more reliable data of other investigators on the soda-silica glasses fall on the same straight lines found in this study. The only exceptions are a few reported observations on glasses containing very large and very small amounts of soda.

**6. Measurement of the Surface Tension of Viscous Liquids.** *By C. A. Bradley, Corning Glass Works.*

Using the maximum bubble-pressure method (Fig. 2) with the modifications described by Parmelee the author tested the applicability of the method by measuring the surface tension of a series of solutions of rosin; i.e. ben-

L. C. Roche

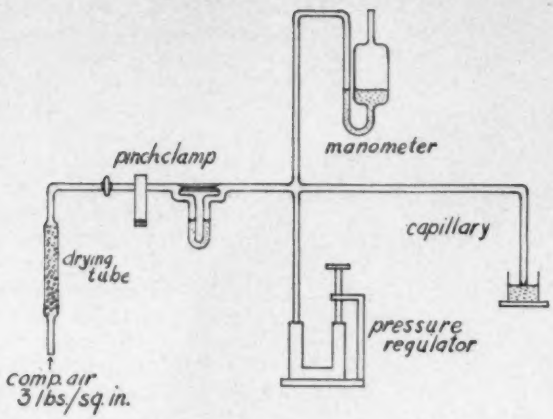



**Fig. 2.**

zol-benzoate whose viscosities varied from 100 to 2,500 poises. A technique for the approximate measurement of surface tension by means of sessile drops was also described. Table I gives the values for the surface tension of four different glasses as determined by both methods.

The results reported indicated that the maximum bubble-pressure method can be used to determine the surface tension of molten glasses with an accuracy of about one per cent, if the glasses are well-mixed and their compositions do not change on heating. If these conditions are met, the precision obtained is a function only of locating the capillary in the glass surface and the precision of the pressure determination. If rapid and approximate surface tension determinations are required when only small amounts of glass are available, the sessile drop method is satisfactory, and has the advantage of requiring very little equipment for its use.

TABLE I

| *Glass No.* | 1*a* | 4 | 5 | 6 |
|---|---|---|---|---|
| Surface Tension I (dynes/cm) | 294 | 320 | 329 | 360 |
| Surface Tension II (dynes/cm) | 322 | 335 | 347 | 368 |

I. Values obtained by the sessile drop method.
II. Values obtained by extrapolation of the bubble-pressure results.

**7. The Law of Annealing of Glass: Quantitative Treatment and Molecular Interpretation.** *By Nelson W. Taylor, Dept. of Ceramics, Pennsylvania State College.*

X-ray evidence indicates that the silicon and oxygen ions in glass form tetrahedral $SiO_4$ groups which link together by sharing of common oxygens or by attraction of positive ions such as $Na^+$, $Ca^{++}$, etc., to form a "random network." This network is broken in places in consequence of thermal motion, and if the temperature is sufficiently high there will be many dissociated units (broken pieces) irregular in shape (chains, corkscrews, warped sheets, etc.) all carrying an electric charge.

If such a molecular mixture is quickly cooled, this dissociated condition is preserved, and changes very slowly. The change, however, is in the nature of a combination or joining of the small units to form larger aggregates. The rate of such a change is given by the ordinary laws of chemical reaction kinetics, i.e. $-\frac{dx}{dt} = kx^2$. This expression is a convenient way of stating that the rate at which the dissociated units, x, disappear (to form larger ones) is proportional to the number of collisions between them. In other words, they won't stick together unless they collide.

A simple analogy is given by automobile collisions. The probability of collision of automobiles with one another in a given area is determined not by the number of automobiles but by the square of that number. Similarly, if there are x ions of glass in a definite volume the chances of collision of pairs of these ions is $x^2$.

The Adams and Williamson equation follows directly from this simple picture if we assume that the strain $\delta_{tot}$ resides in the dissociated ions x, for since $-\frac{dx}{dt} = kx^2$ we may write $-\frac{d\delta}{dt} = K_2\delta^2$ (for strain) or $-\frac{df}{dt} = k_2f^2$ (for stress).

The strain is then released as fast as the dissociated units react with one another to form larger aggregates. In the early stages of annealing the strain is found to disappear more rapidly than this, and in fact this "excess" rate is proportional to the amount of "excess" strain present. The suggested explanation is that part of the strain can be relieved (1) individually by some ions, perhaps by changing their shape (e.g. coiling or crumpling); and (2) by interaction, as described above. For process (1) the mathematical expression is—$df/dt = k_1 f$, for stress release.

In support of the assumption that the strain resides mainly in the dissociated units or ions, we have evidence that such ions are more easily polarized (oriented or deformed) by an electrostatic field (i.e. they have a higher dielectric constant) than the associated aggregate, and it is to be expected that mechanical polarization (stress) will have the same effect. Furthermore, certain direct experiments on the birefringence of simple molecules under mechanical stress and on the flow of liquids under high pressure show that chain-shaped or rod-shaped molecules become oriented or aligned by the external stress much more easily than do large symmetrical aggregates such as an undissociated 3-dimensional network would probably be.

This paper gives a simple interpretation of the Adams and Williamson annealing equation, and shows how the rate of molecular association can be studied, and finally gives a simple picture of the nature of molecular strain in glass under the influence of compression or tensional stresses.

**8. A Discussion of Factors Involved in Stress Release.** *By Howard R. Lillie, Corning Glass Works.*

The Adams and Williamson annealing law has, in a sense, revolutionized lehring practice since it expresses empirically the stress-time relation in glass at temperatures in the annealing zone. However, although several attempts have been made to justify the law by fundamental considerations, these attempts fail because the law itself has no fundamental significance.

A consideration of physical factors involved in determining the rate of change of strain, which in turn deter-

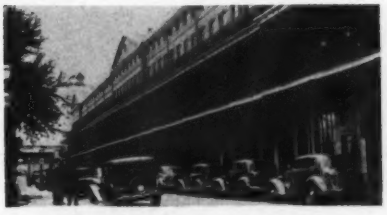
...e of New Orleans famous eating places, familiar rendezvous of the Glass Division.

Mellon Institute and the Bureau of Standards go to sea; Dr. and Mrs. Tillotson and Dr. and Mrs. Lundell on the Mississippi.

Typical wharf scene — unloading bananas.

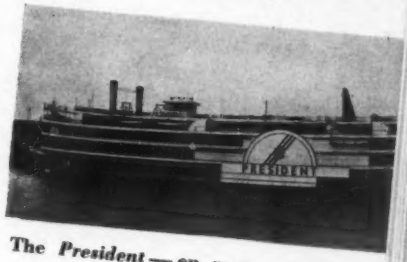
Dr. L. G. Ghering and E. G. Bourne aboard the *President*.

V. C. Swicker and chairs.



Looking south from Jackson Square

The new membership chairman (Ogd... receives instructions from his predece... (Hettinger).




The *President* — en route to nowhere particular.

Stern Wheeler tied to wharf.

...ne, typical of the French Quarter.

O'Mara White, with Louisville in the distance (1,000 miles away).

Hettinger — applying the tilting test.

A. N. Finn and tomb.

mines the annealing rate, leads to a modification of the Maxwell law in which the instantaneous rate of decrease is proportional to the stress itself, the constant of proportionality being equal to a modulus term multiplied by a fluidity term.

The Maxwell law has a serious drawback: although it is followed when momentary rates are considered as a spatial function of stress, it is inadequate when the rate of release at any given point is considered as a time function alone. The Adams and Williamson law is subject to the reverse limitation since it always deals with rates at a given point and becomes absurd when the spatial distribution of rates is considered. Accordingly, an acceptance of the Maxwell law requires that some governing property of the glass must change with time, while in the case of the Adams and Williamson law there must be a spatial variation of some property. Obviously the former of these requirements seems the more likely to be met.

It has been known for some time that there is apparently a large time-variation of fiber-stretch rates in the annealing range and that this variation takes place even during heat treatment in the absence of stress. It is therefore associated with a spontaneous atomic rearrangement of some sort. The exact mechanics of this change are not known but it is logical to argue that the mobility factor entering into the stress release law changes with time in a similar way. We then have the following law:

$$-\frac{df}{dt} = M f \zeta$$

where $f$ is stress, $t$ is time, $M$ is a modulus and $\zeta$ is a mobility or fluidity factor.

If at any given time both $d(\log f)/dt$ and $\zeta$ are known, their ratio $M$ may be computed. This ratio is found to be essentially constant with time and equal to about ⅛ to ¼ of the shear modulus.

Such an analysis has been found to apply satisfactorily to all annealing data so far determined by the writer. It is therefore concluded that the modified Maxwell law for stress release is correct and that emphasis should be placed upon finding the reasons for the spontaneous change in properties which account for the empirical accuracy of the Adams and Williamson law, rather than on a fundamental justification of the law itself.

**9. Effect of Glass Color on the Setting Rates of Glass in the Manufacture of Glass Bottles.** *By O. G. Burch and C. L. Babcock, Owens-Illinois Glass Co.*

While manufacturing bottles of the same weight, capacity and shape by both the Owens and flow processes, it was observed that higher machine speeds could be obtained from colored glasses than could from the so-called flint glasses. For example, with the 10-arm Owens machine working on 26 to 32 ounce capacity and 26 to 28 ounce weight containers, it was possible to obtain a machine speed of 27 bottles per minute with emerald green glass, while the limit (determined by the speed at which the bottles began to run out of shape) with flint glass was 23.5 bottles per minute. In the case of a flow machine working 16 to 32 ounce capacity and 14 to 28 ounce weight containers, a speed of 20.8 per minute was obtained with amber glass and only 19.9 with flint glass.

A laboratory apparatus (Fig. 3) and technique was described by which the cooling rates of both colored and flint glasses through the working range could be measured. Briefly, the apparatus consists of a movable electric furnace in which the glass sample is heated to the desired temperature and a sensitive thermocouple for measuring the temperature. The cooling curves are determined by immersing the bead of the thermocouple to the desired depth in the glass, bringing the glass to the desired temperature, removing the furnace and measuring the time required for the glass to cool to a predetermined temperature. Typical results are given in Table II.

TABLE II

| *Glass No.* | 1 | 2 | 1 | 2 |
|---|---|---|---|---|
| *Glass Color* | *Flint* | *Green* | *Flint* | *Green* |
| *Temp. Range °F* | 2178-1485 | 2124-1459 | 2178-1294 | 2124-1273 |
| *Depth (mm)* | | | | |
| 1 | 81 | 74 | 128 | 121 |
| 3 | 103 | 98 | 159 | 154 |
| 5 | 117 | 113 | 179 | 174 |
| 10 | 143 | 139 | 215 | 210 |
| 20 | 164 | 160 | 240 | 240 |
| *Glass No.* | 3 | 4 | 3 | 4 |
| *Glass Color* | *Flint* | *Amber* | *Flint* | *Amber* |
| *Temp. Range °F* | 1980-1477 | 1980-1477 | 1980-1310 | 1980-1317 |
| *Depth (mm)* | | | | |
| 1 | 62 | 57 | 103 | 98 |
| 3 | 82 | 79 | 126 | 123 |
| 5 | 93 | 91 | 144 | 144 |
| 10 | 112 | 110 | 170 | 170 |
| 20 | 132 | 131 | 196 | 196 |

NOTE: Figures represent time in seconds.

It was concluded that although the apparatus and procedure used do not duplicate actual operating conditions, the results obtained do allow an estimate to be made of the comparative working speeds of colored and colorless glasses.

The greater setting rate of colored glasses can be explained, as a result of this work, as being almost entirely

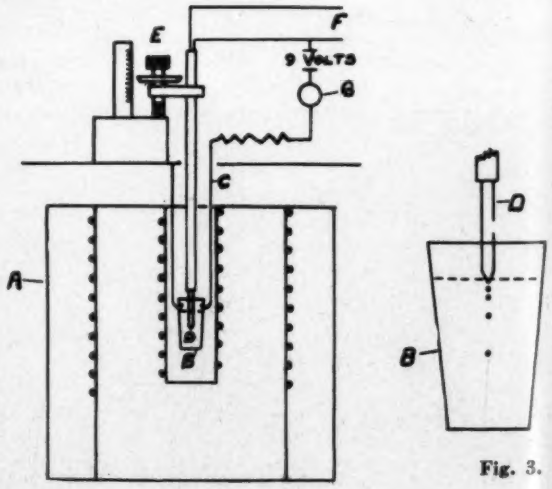



Fig. 3.

due to the greater rate of loss of heat by radiation from their surfaces, thus causing the viscosity of the glass comprising the surface to increase faster and thereby form a "skin effect" quicker than does the colorless type of glass.

**10. Fluorescent Glasses.** *By Woldemar Weyl, Department of Ceramics, Pennsylvania State College.*

The radiant energy absorbed by colored glasses in the ultra-violet, the visible region, or the infrared usually is turned into heat. In some cases the radiation, however, causes chemical changes in the glass, which give rise to discoloring (solarization). For example, decolorized glasses containing manganese become purple after exposure.

There are other cases where a part of the energy absorbed is emitted in the form of light. The short wave portion of the spectrum is most effective in causing light emission (fluorescence). The fluorescence of glass depends upon the nature of the absorbing ion, the composition of the base glass, and the temperature. The fluorescence of uranium glasses is well-known and consists of five sharp bands, if the glass does not have a strong perturbing action.

The structure of this fluorescence spectrum will change with the amount of alkali in the glass. Such spectrum changes can be used to determine constitutional properties. For example, manganese causes a green fluorescence in silicate glasses, whereas its fluorescence in borates is red. It has been suggested to use this change for studying the constitution of borosilicates.

In the use of fluorescent glasses for increasing the efficiency of light sources, it is desirable that the fluorescence be strong. For this purpose new glasses have been developed with the idea that the absorbing particle is so isolated in the glass that it can not give off its energy in any other way except as light. By treating silver containing glasses with hydrogen, a glass results which contains the silver in the form of neutral molecules. This glass shows a strong fluorescence due to the silver being in a gas-like distribution.

**11. A Numerical Evaluation of the Constant in the Gladstone and Dale Equation.** *By A. N. Finn, National Bureau of Standards.*

It was shown that the specific refractivities (R) of the various glass-forming oxides could be empirically expressed in terms of the ionic radii and the hydrogen equivalent weights of the oxides. In these relations, the oxides fall into two groups, one of which has twice the effect of the other. From these, the constant of the Gladstone and Dale equation can be estimated for each oxide from its molecular weight and atomic radius.

**12. Elastico-viscous Properties of Certain Potash Silica Glasses.** *By Nelson W. Taylor and Robert Doran, Department of Ceramics, Pennsylvania State College.*

Recently completed work on the elastico-viscous properties of a glass containing 25 per cent $K_2O$ was compared with the previously reported results obtained on a soda-silica glass containing 18 per cent $Na_2O$ (same mol-fraction of alkali).

It was shown that the potash glass is approximately three or four times less viscous at 445°C, while at lower temperatures the ratio is still greater. The release of elastic strain (delayed elastic effect) runs more rapidly in the potash than in the corresponding soda glass, while the activation energy for viscous flow is roughly 95,000 calories as compared with 150,000 calories for the soda glass.

The reason for these effects is to be attributed to the weaker electrostatic forces binding $K^+ - O^=$ as compared with $Na^+ - O^=$. This weakness results from the larger size of the potassium ion, (the radii being 0.98 and 1.33A respectively for $Na^+$ and $K^+$).

The potash glass, because of its greater dissociation than the corresponding soda glass at the same temperature, shows more complexity in its elastic behavior. A small percentage of the molecules undergo elastic adjustment faster than the majority, yet slower than the instantaneous group. They provide a transitional group.

The theory, previously announced, that the whole elastic effect can be resolved into an instantaneous part and a delayed part with a definite rate constant, is probably an over-simplification. It would be more correct to assume that the "instantaneous part" is really a very fast process but with finite speed, and is due to the elastic adjustment of the smallest dissociated ions; and that there are all stages of rates due to the variety of sizes of ions in the glass. The simpler theory, nevertheless, gives a quantitative expression of the data in many cases.

The work is being continued.

**14. Ring Section Examination of Glass Containers.** *By V. C. Swicker, Hartford-Empire Co.*

A brief review of the literature on the use of the polarizing microscope for the examination of cordy glass was given. The procedure as used by the author was described in detail and in brief is as follows:

Rings about one half inch thick are cut from the bottle using a hot wire in the case of simple shapes, or a cutting wheel in the case of irregular shapes. The ring, which must be complete and without cracks, is placed in a glass dish and covered with monochlor benzol. This is placed on the microscope stage and the ring examined under crossed nicols using a sensitive tint plate (first order, red). Low magnification is used to include the entire width of the sides of the ring. The ring is rotated on the stage until the maximum color showing is obtained.

Cords in the glass appear as brush marks usually surrounded by a strained area. It is extremely important that the entire ring be examined taking care that all observations are made in the same plane, as the colors denoting tension and compression reverse as the plane is changed. It is desirable to examine the ring in the plane at which tension appears blue and compression appears yellow. This direction can be found by mechanically stressing a sample of glass while viewing it under the microscope.

During the ring section examination the following observations were made: the size, distribution and direction of the cords; the strain due to the cords and the annealing strain; the nature and order of such strain; and casing defects.

From these observations an alphabetical grading is given to the glass. The grades used run from "A" to

"Pirates Alley," with ceramists.

Arcade of the Cabildo, which played such a prominent role in the early history of New Orleans.

Stairways in French Quart

## CAMERA STUDIES

The old French Quarter of New Orleans literally abounds with quaint courtyards, wonderful iron railings, curved stairways, quaint personalities — a veritable heaven for the camera artist. It is known to all that the Glass Division boasts among its members a number of amateurs whose photographic talent is quite outstanding. So, in addition to the pictures of the membership in action, seen on preceding pages, we have included here a few of their more interesting studies. For these, and for all the snapshots taken at the New Orleans meeting, THE GLASS INDUSTRY acknowledges a profound debt of gratitude to J. Earl Frazier, E. L. Hettinger, Royden A. Blunt and E. G. Bourne, who so generously supplemented the work of staff photographer Frank Bardorf.

"Corncob." A study by Hettinger.

Curved stairway.

Orchestra." Another by Hettinger.

A. N. Finn, Mrs. L. C. Roche, W. R. Lester and pillar emerging from the absinthe bar.

Iron grille work, for which New Orleans is famous.

Courtyard.

Packingham's Trees.

Mammy.

Street scene.

"E" and denote glass ranging from commercially perfect to dangerous and unusable.

A series of lantern slides were then given which consisted of color photomicrographs of various ring sections that had been examined by the author. These included examples of all types of cordy conditions.

It was pointed out that the routine examination of ring sections was not intended to replace any of the tests for glass quality now in use by the glass manufacturer, but was being advocated as an additional tool for such work.

**15. Relative Solubility of Glass in Acid Solutions as Indicated by Dye Absorption.** *By E. H. Hamilton and A. N. Finn. National Bureau of Standards.*

While investigating the rate of solution of glass in acid solutions by an interferential method it was observed that treatment of the attacked surface with a suitable dye (i.e., one that would be absorbed by the silica layer), would allow an estimate of the severity of attack to be made.

Preliminary experiments with samples of flat glass and a miscellaneous lot of bottles showed that the method had possibilities. Further work, using the standard durability sample glasses Nos. 1 and 4 (the horse radish bottle and flat glass samples used in the tests of the powder method), showed that the absorbed dye method ranked the two glasses in the same order as found by the powder method. Bottles of known durability, obtained from several glass companies, were then tested by the dye method, using a standardized procedure and the results obtained compared with the known durabilities. With one set of bottles good agreement was obtained. In another case, three out of four glasses checked out satisfactory, the only discrepancy being an amber glass. This glass refused to "take" the dye regardless of the treatment used. During the discussion it was mentioned that the dye used is decolorized by sulphides, and this lack of dye absorption by the amber glass may be due to the high sulphide content of this type of glass.

The method as used at present (for bottles) is as follows: Wash with soap and water, one per cent acetic acid and finally three times with distilled water. Fill with standard potassium acid pthalate solution adjusted to $_{P}H6$ with NaOH. Heat in a water bath at 80°C for 24 hours. Remove and wash out with distilled water. Fill with a 0.006 per cent solution of Victoria Blue and let stand for 30 minutes. Wash out with distilled water (the absorbed dye is retained on the surface). Ring sections, one inch high, are cut from the bottle and the dye extracted with alcohol. Comparison of the dye concentration in the extract with the standard dye solution is a measure of the relative solubility. From the ring section the glass area can be calculated and the dye absorption measured quantitatively.

It was concluded that the method as it now stands is satisfactory for determining the comparative durabilities of similar glasses. The investigation is to be continued.

**16. Outline Study Course on Mechanical Properties of Glassware, with Particular Reference to Glass Containers.** *By F. W. Preston, Butler, Pa.*

In the absence of Dr. Preston a brief summary of this paper was given by Dr. Gehring. The paper, which is rather lengthy, consists of 18 different memoranda on the subject of glass breakage and methods of tests. It is an outline introduction to the subject, being written at the request of the Glass Container Association Test Committee in the belief that, in both the universities and plants, there are men who would like to qualify themselves to understand the issues involved but do not know how to start. No attempt was made to make the paper a comprehensive treatise on the subject.

Dr. Gehring gave a brief digest of the material appearing in each memorandum. In No. 1 the general principles of the various causes of glass breakage are discussed. It was pointed out that a broken bottle is not just a mass of meaningless cracks, but that the cracks are a definite response to the forces producing them, and that their study will allow the correct meaning to be found. In addition, a crack has only one immediate cause i.e., mechanical stress. This stress is always a tensile stress.

No. 2 illustrates and discusses examples of typical pressure fractures, thermal shock fractures, and fractures due to blows. Memorandum No. 3 deals with the subject of the theory of elasticity and its relation to glass breakage. In No. 4 various experiments are given for the purpose of showing that fractures do not originate spontaneously but that they have a minute starting point, a definite direction of travel and a finite velocity of propagation.

In No. 5 the fact that fractures begin at the surface is discussed, leading up to the velocity of propagation of the fractures, which is treated in Memorandum No. 6. The forking of cracks and its meaning are given in No. 7.

The influence of annealing on glass breakage is covered in No. 8, and typical experiments concerning this phase are given. No. 9 covers crushing strength and impact strength tests. It is shown that compressive tests do not break the glass but that the break is always caused by unintentional tensions developed during this type of test.

In Memorandum No. 10 numerical data concerning the strength of glass is presented. No. 11 discusses the "time factor" in the testing of glass, duration testing, fatigue and repeated testing. The use of the "Theory of Errors" in expressing the results of tests on glassware is treated in No. 12 and it is shown that the Normal or Gaussian Curve, while not strictly applicable, does in some cases come quite close to representing the facts. This is especially true in the case of thermal shock test data.

The need of determining the variation (if any) of the strength of glass with temperature is discussed in Memorandum No. 13. In No. 14 the theory of bottle strength under pressure is given and the mathematics involved presented. No. 15 deals with the theory of thermal shock. Memorandum No. 16 discusses the theory of the polariscope and includes the method of use of the standard annealing discs recently developed by the Glass Container Association. A short discussion of the deterioration of glassware with age is given in No. 17. The outline is concluded with a list and description of suitable equipment for testing the annealing, internal pressure resistance and the resistance to thermal shock of glass containers.

### G. C. A. SPRING MEETING

The Glass Container Association has announced that it will hold its annual meeting at White Sulphur Springs on May 26 and 27. The date is somewhat later than usual, and was chosen in an effort to avoid the rainy weather frequently encountered in the early part of May. A schedule of meetings has been tentatively set as follows:

Wednesday, May 25: Meeting of Board of Directors, Committee meetings.

Thursday, May 26: General Session, Golf Tournament, Annual Dinner.

Friday, May 27: Glass Division Meeting.

### A. C. S. ELECTS HONORARY MEMBERS

Among the honorary members elected by the American Ceramic Society on March 31, 1938, was Frederick Carder of the Steuben Division of the Corning Glass Works. Mr. Carder since winning the National Gold and Silver Medals for sculpture during his student days in England, has contributed much to the development of glass as a material for decorative design in architecture. He has exhibited his work at the Metropolitan Museum of New York and has the unusual distinction of a large permanent exhibit in the Smithsonian Institute, Washington.

Mr. Carder has made a number of installations in the architectural field, prominent among them being the glass in the elevator lobbies of the Empire State Building, New York City—the large 55-foot panel screen in the Rockefeller Center Office Building, New York—and in the Corning, N. Y., Public Library, a window of sculptured glass commemorating the sons of Corning who gave their lives in the World War. When the Steuben Glass Works was united with Corning Mr. Carder became art director of that organization and has served since in that position.

In 1927 Mr. Carder was awarded the Friedsam Gold Medal by the Architectural League, which is awarded periodically for the highest service to art and industry. He is a fellow of the Royal Society of Arts, London; a member of the Architectural League of New York, of the American Chemical Society and of the Illuminating Engineering Society.

Others to receive honorary membership in the American Ceramic Society include Lucien Delloye, retiring director of the Campagnie de Saint-Gobain, Paris, France; Mary Louise McLaughlin, 4011 Sherwood Ave., Cincinnati; and Colonel C. W. Thomas, E. J. & J. Pearson, Ltd., Stourbridge, England.

**The candid camera catches Mr. Carder.**

### URBANA GLASS CONFERENCE IN MAY

The fifth conference on glass problems, sponsored by the Department of Ceramic Engineering of the University of Illinois, will be held in Urbana, Ill., on May 20 and 21. Professor C. W. Parmelee will serve as chairman of this meeting which will be devoted primarily to papers on glass batch problems and a discussion of glass forming molds. Following are the papers and speakers on glass batch problems:

Friday, May 20, 1:40 P.M.—

1. "Batch Handling," by A. D. Schiller, Corning Glass Works.
2. "Batch Mixing and Handling," by E. E. Milner and E. E. Milner, Jr., Ball Brothers Co.
3. "Feeding Batch to Tank Furnaces," by V. C. Fugman and H. I. Vormelker, General Electric Co.
4. "Briquetting of Glass Batch," by F. G. Schwalbe, Toledo Eng. Co., Inc.
5. "Description of a New Installation for Batch Preparation." (Details to be announced later).

The discussion of these papers will be led by D. D. Burress of Ball Brothers Co.

Friday, May 20, 7:30 P.M.—

6. "Electric Melting of Glass," by Y. R. Cornelius, Englewood, N. J.
7. "Natural Laws Hurdle National Boundary," by Z. C. Kline, General Electric Co.

On Saturday, May 21, beginning at 9:00 A.M., there will be a discussion of glass forming molds under the chairmanship of G. G. Hanson of the Colorado Feldspar Co. Papers to be read at this meeting include the following:

8. "Fabrication of Glass Ware: Mold Faults and Remedies," by G. B. Langer, Lynch Corporation.
9. "Developments in Mold Irons," by J. S. Vanick, International Nickel Co., Inc.
10. "High Test Irons," by F. W. Dixon, Jr., Gunite Foundries Corporation.
11. "Concerning Colloidal Graphite and Its Utility in the Glass Industry," by R. Szymanowitz, Acheson Colloids Corporation.

### SILVERMAN TO REPRESENT U. S.

Alexander Silverman has been appointed by the United States Government as a delegate to the Tenth International Congress of Chemistry, being held in Rome, May 14-21. At the same time, Dr. Silverman will represent the National Research Council and the National Academy of Sciences at the Thirteenth Meeting of the International Union of Chemistry, under the auspices of which the Congress is meeting.

### "SNOW WHITE" MAKES NECESSARY $500,000 ADDITION TO PLANT

Libbey Glass Co., Toledo, is building a $500,000 addition to its factory. Large orders from food packers, particularly cheese, for tumblers to be given away as premiums, have been said to make necessary an increase in manufacturing facilities. A hurry call was recently sent out to the Austin Company, which is building the addition, to complete 135,000 square feet ahead of schedule, because of a veritable deluge of orders for tumblers decorated with Snow White and the Seven Dwarfs.

# HOLLOW GLASS BRICKS

By BERNARD LONG
Director of the Central Laboratory, Saint-Gobain Co.

The use of hollow glass bricks for building walls seems to have first been suggested by Falconnier. In a patent drawn up in 1887, the inventor has shown that hollow blown glass, resembling bottles, whose lateral surfaces have edges for holding the mortar and reinforcing strips, lend themselves readily to the construction of walls that are light in weight and that offer good heat insulation. Their rather poor resistance to compression and impact has limited the use of Falconnier bricks to openings of relatively small height, such as windows and bays. In fact, such uses have been very few and the installations which have taken place to date, very rare.

After a period of new construction, during which pressed glass combined with concrete was spectacularly introduced into modern building, the idea of the hollow brick has recently been taken up again and put into operation in various places in the form of two half bricks with an air-pocket between them.

Three welding procedures merit attention:

(a) Autogeneous welding, which consists of pressing together the edges of half bricks previously brought to the softening stage.

(b) Welding by a metal film, which consists of pressing together the edges of the half bricks previously covered with a metal film by soaking in a molten aluminum alloy, at a temperature about 750°C.

(c) The welding of the half bricks with solder at a temperature about 200°C, after they have been hardened and their edges have received a special metal coating.

Although a detailed discussion of the advantages and disadvantages of the three procedures is not the theme of this paper[1], I wish to stress one very important fact: that the first two procedures exclude all possibility of obtaining a hardened hollow brick. To one who understands the exceptionally great resistance which hardening gives to pressed ware, this is a very serious disadvantage.

We shall consider the principal properties of hollow bricks obtained by the third process on a brick 30 x 30 x 10 cm. called "Verisolith" which, on account of its size and weight (9 kg.), is a convenient type for both manufacturer and builder. Fig. 1 represents the two constituent half bricks; Fig. 2, the "Verisolith" brick.

### Mechanical Properties

During recent years, we have frequently drawn attention to the very great superiority of hardened pressings over annealed pressings, so far as resistance to edgewise compression, resistance to mechanical and thermal shock, or even resistance to various stresses which develop in "translucent concrete"[2] are concerned. For this reason we shall not give further emphasis to the exceptional mechanical properties of the "Verisolith" brick which, obtained by welding two hardened half bricks, is on the whole a hardened hollow body. Rather, we shall limit ourselves to a comparison of the results of two series of compression tests, one on "Verisolith" bricks, and the other on bricks of the same size and weight, manufactured according to the autogeneous procedure (S. A.).

In the first series of tests, resistance to flatwise compression in a press was studied. The bricks were placed on an asbestos sheet resting on the lower plate of a press, and a concentrated load, steadily increasing until the glass broke, was applied at the center of the bricks' upper surfaces through a 50 mm. cubical steel block, an asbestos sheet having been placed between the steel block and the glass. For nine "Verisolith" bricks, the breaking load was, on the average, 3020 kg; for nine annealed bricks S. A., the average was 810 kg.

In a second series of tests, the resistance to edgewise compression was tested in a press. The bricks were placed vertically between the two parallel, horizontal plates of the testing press and a concentrated load steadily increasing to the breaking point was applied through

[1] From a paper presented before the 17th Congress of Industrial Chemistry, and translated from Verres et Silicates Industriels, Jan. 1938, by B. J. Beattie, Butler, Pa., for THE GLASS INDUSTRY.

[2] "Beton translucide": reinforced concrete with pressed glass fillers transmitting light.

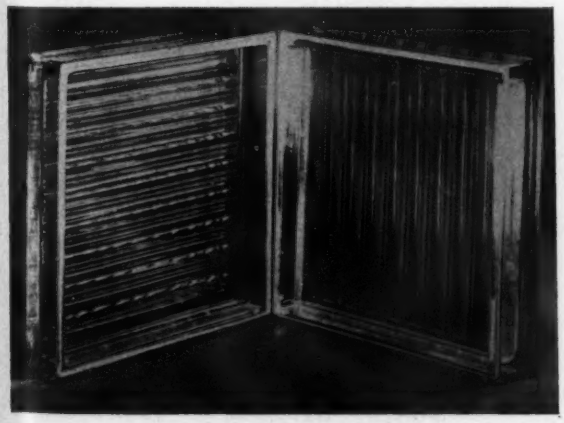


Fig. 1.

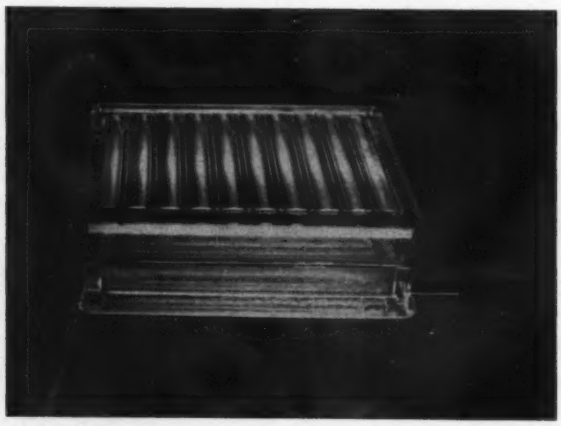


Fig. 2.

two wooden blocks, each 50 x 50 mm., with a flat face in contact with the plates of the press, and taking the form of the side of the brick on the opposite face. Nine bricks of each manufacture were tested. The breaking load was, on the average, 3700 kg. for the "Verisolith" bricks, and only 620 kg. for the annealed S. A. bricks.

**Optical Properties**

In modern building, the principal requirement of glass pressed into concrete is that it will transmit a large amount of light. The user is particularly interested in knowing the value of the transmission factor of each type of pressing; that is to say, the ratio between the light flux transmitted and the incident light flux.

Without denying that such glass-in-concrete walls quite often receive direct radiation from the sun; still, in our latitude, it can be said that bricks are most frequently lighted in present day use by light diffused from the sky. And it is the transmission factor in diffuse light which must first of all engage the attention of the architect. In order to measure this optical characteristic, we have used the procedure of the integrating chamber, of which a diagram is given in Fig. 3.

The chamber is in the form of a cube, CH (2 x 2 x 2 meters), whose dead corners have been cut off more or less arbitrarily and whose internal walls have been covered with white diffusing paint. The chamber has a large opening in which the test brick B is fitted, and a small opening w closed by an opal glass, against which is placed the photometric apparatus.

Brick B thus receives diffused light coming from an opal glass hemisphere H, behind which a number of lamps L, have been placed. Due to the opaque screen E, the opening w does not receive any direct light.

The light flux transmitted by the brick is evened out by the integrating chamber. Its measurement is made by comparing, by means of a Lummer-Brodhun cube C, the brightness of the wall of the chamber with that of an opal glass V. This latter is varied by moving lamp S, which is attached to the end of a graduated rod movable along the axis of the photometric box.

The matching of the brightness of the photometric fields is made by placing the eye behind the peep-hole O. After the brick is taken from its place, the incident light flux is then measured.

If $d_1$ and $d_2$ are respectively the distances from the lamp S to the opal glass V in the first and the second photometric balances, the transmission factor is measured by the equation: $f = \frac{d_2^2}{d_1^2}$

The transmission factor in diffuse light of the "Verisolith" brick whose lateral faces have been covered by a white opaque coating has the value: 0.40. At first sight, this seems small, but if we consider, on the one hand, that a great part of the incident light flux undergoes great losses by reflection on the entrance face; and, on the other, that an appreciable quantity of light is lost on the lateral wall, the above result no longer surprises us. In fact, it appears excellent when we point out that a hollow "synthetic" brick, 30 x 30 x 10 cm., formed by joining four rectangles of polished glass 30 x 10 cm. (lateral walls) and two squares of polished glass 30 x 30 cm. (main walls), gives in diffuse light a factor of 0.45 when the lateral surface is covered with a thick coat of dull white paint.

For certain uses, it may be interesting to know the value of the transmission factor in parallel and normal or perpendicular light. The integrating chamber lends itself very readily to this measurement.

In the installation previously described, it is sufficient to remove the opal glass hemisphere and project a beam of parallel rays on the brick; for example, rays produced by a projector placed a few meters in front of the chamber and having for its principal axis, the normal to the center of the brick. It is then found that $f = 0.56$. It is interesting to note that the accuracy of the method, completely sufficient for the needs of the architect, is $\pm$ 5 per cent.

We shall conclude this brief survey on optical properties by pointing out that the principal walls of "Verisolith" brick have internal cylindrical and prismatic flutings, giving the whole a great number of deformed and confusing images; consequently. the whole appearance is distorted through the glass.

**Heat Loss**

One objection often made to the use of glass bricks in building translucent walls is that they lose a considerable amount of heat in winter, and also because they are responsible for condensation, when they separate a heated room from the outside atmosphere. Both of these drawbacks are eliminated by the use of hollow bricks having an air chamber. These are specially valuable for use in the front of buildings; they transmit an

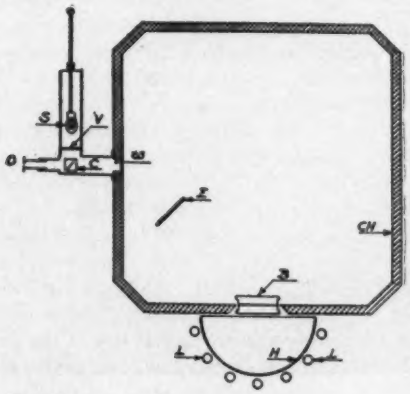



Fig. 2.

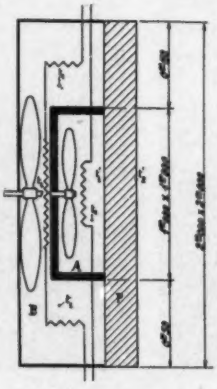



Fig. 3.

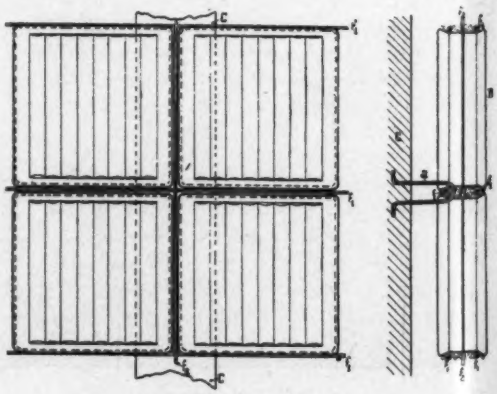


Fig. 4.

abundance of light into dwellings and working quarters, as prescribed by modern hygiene and good lighting.

The total heat loss by "Verisolith" brick walls has been studied at the Experimental Laboratory of the Arts and Crafts Conservatory. Fig. 4 is a diagram of a horizontal cross section of the experimental apparatus. The principle of determining the factor of heat loss is:

Two concentric boxes A and B with square sections of 2 x 2 m. and 1 x 1 m., without lids, are fastened by their openings against a wall of 36 bricks, placed in a room at a substantially constant temperature. Each box contains a heating coil and a fan revolving just fast enough to equalize the temperature of the enclosed air. The heat is regulated in such a way that the temperature of the air is the same in the two boxes ($t_1$).

Under these conditions, the external box acts as a guard ring preventing any lateral heat transmission. The heat developed by the Joule effect in the internal box A is transmitted entirely through the wall perpendicular to its sides. From this quantity of heat Q and from the difference of temperature of air in contact with the faces of the wall ($t'_1 - t'_2$), the factor of heat loss is deduced as follows: $F = \frac{Q}{t'_1 - t'_2}$

In terms of the usual units (Kilogram-calorie, square meter, hour, degree centigrade), the average factor of heat loss between 25° and 50° of a "Verisolith" brick wall or panel has a value of 4.5.

By way of comparison, let us point out that a wall of solid glass bricks 20 x 20 cm., 8 cm. thick, under the same experimental conditions as above, has a value of 4.5. If the saving in weight is considered, it may be concluded from this comparison that the "Verisolith" brick is particularly advantageous.

It might be thought that bricks made by the autogeneous soldering procedure, because their air chamber contains very rarified air, would be definitely superior to "Verisolith" bricks, as far as total heat loss is concerned. This is not the case; in fact, tests made at the Laboratory of the Conservatory of Arts and Crafts have shown that the average value of heat loss in the neighborhood of room temperature of a wall of the autogeneous welded type, having the same size and weight as "Verisolith" bricks is, within the limit of experimental error, equal to 4.5.

This result will cause no surprise to informed insulation engineers; for since the heat loss from hollow glass bricks occurs mainly through radiation, a small reduction in loss by conduction does not affect the result.

By way of confirmation, let us describe the considerable decrease of the loss of the heat factor which is obtained by placing spots of aluminum on the wall of the air chamber before soldering the hardened half bricks. The lower value 2.8 is then reached.

To better emphasize the importance of the saving thus obtained, it should be noted that this value is within 10 per cent of that found for the heat loss factor of a wall 20 cm. thick, built with hollow bricks with holes 8 x 16 x 30 cm., and covered on the exterior with a coat of cement 2 cm. thick, and on the interior, with a coat of plaster 2 cm. thick.

The hardened hollow brick flecked with aluminum, called "Aluver" brick, is doubly valuable because on the one hand its insulating ability is large, and on the other, its transmission factor for diffuse light is still 11 per cent. For extensive use in facades, it represents a wise compromise between "Verisolith" brick which, although it radiates light well, has not perhaps enough insulation, and the ceramic brick with holes, whose insulation is satisfactory, but which is opaque.

Fig. 5.

It is likely that when using the "Verisolith" and "Aluver" bricks together, the quantity of light and insulation desired will be obtained readily with the advantage of maintaining the homogeneity of the facades and small expense of upkeep. Besides, it will be possible to derive from this association varied ornamental effects which eliminate the monotony some critics have not been slow to attribute to glass facades.

We might say here that a wall of "Aluver" bricks of an identical surface weighs 2.5 times less than a wall of hollow fire clay bricks, discussed above.

Fig. 5 clearly indicates the method of setting up the "Verisolith" bricks. The grooves on the surface hold the reinforced concrete whose duty it is to insure the cohesion of the wall. It is not absolutely necessary to use vertical and horizontal iron supports for each brick. Depending on the size of the wall, reinforcement every two or three rows is sufficient.

In the particular case of Fig. 5, we are concerned with the interior of a wall over 15 m. high in the Pavilion of the Saint-Gobain Company, at the 1937 Paris Exposition. The amount of concrete is 300 kg. The reinforcement consists of 10 mm. iron rods. There is one vertical reinforcing rod for each brick and two horizontal rods for every second brick. The wall is tied to the reinforced concrete columns of the main structure by cramp-irons "a" which pass between the horizontal reinforcement $f_1$.

# GLASS NEWS FROM ABROAD

**Belgium**—Uncertainty is still the key-note in the Belgian industry; business in all sections is slack and foreign orders are negligible. But there is still the hope that with the summer coming on conditions will improve. Meanwhile the Verrerie du Centre of Houdang, an important producer of blown glass ware, has closed down.

**Brazil**—The American Consulate General at Sao Paulo reports that U. S. Glass manufacturers are not only obtaining but a small percentage of the rapidly growing demand for foreign made glassware in Sao Paulo but are actually losing ground. During 1936 the States of Sao Paulo imported glassware valued at over $600,000 (almost half of Brazil's total imports of these articles) of which Germany supplied 42 per cent, Belgium 23 and the United States 14. Window glass, laboratory ware, insulators and tableware are the leading items.

**Britain**—Chance Bros., "Protex" glass, which keeps out infra-red and ultra-violet light, is now being produced in a hard form, claimed to be five times as strong as the original glass.

**Chile**—Chile's new window-glass firm, Fabrica de Vidrio Planos de Lirquen, has been at work for nearly a year now, and various estimates put its annual output at between 3,600 and 4,500 tons about equal to the imports from Belgium and Germany. Protected by an import quota restricted to 800 tons and tariffs which were recently doubled, the firm is supplying the home market and building up an export trade to neighboring countries with the help of a bounty.

**Czechoslovakia**—The hollow glass Cartel has been negotiating with the industries of competing European countries, Germany, Belgium, Holland, Austria, Hungary and Jugoslavia, about price agreements for common markets. In many cases definite prices have been fixed already. In the past year it was the plate glass and pressed glass sections of the industry which benefited most from the expansion of foreign markets and now that more prosperous conditions prevail—exports last year were worth 737 million crowns, against 609 million in 1936— manufacturers of blown ware want their share of prosperity.

**Denmark**—Kastrup Glasvaerk, makers of hollow glass ware, are planning to modernize their plant and increase its capacity. For this purpose the firm are doubling the capital by about $460,000. The Danish window glass industry has also been doing well, thanks to a 25 per cent tariff and a well-kept sales agreement. The Currency Office have cut off the cheapest sources of supply, Belgium and Estonia, and only grant import permits for German glass. Meanwhile the native factory at Korsor has concluded a market agreement with the German Window Glass Cartel, conceding a fixed share of sales in return for the maintenance of prices.

**Japan**—Glass wool has now been enlisted in Japan's drive for self-sufficiency in natural fibers. Although it is still doubtful whether with present methods a substitution of glass wool for cotton is possible on any large scale, successful applications of the material are on record which show that it may be used to replace asbestos and similar insulating fibers. A glass wool spinning industry has sprung up in the Nagoya area, and even a compulsory conditioning system for glass wool yarn has been in force since last December. Dr. Kenji Nakanishi, of the Osaka Municipal Industrial Laboratory, recently announced that he has succeeded in developing a process by which white glass wool may be produced from the lava available in Sakurajima (Cherry Island). He claims that he can produce a ton of the material at about 300 yen ($87) as compared with 1,000 yen for the glass wool made from soda ash, lime and silica.

The operation of the Fund Adjustment Law, which was enforced last fall to prevent the flow of capital into "non-urgent" industries, has proved to be a boon to the two plate glass producers who had already completed their expansion plans some time before the law went into effect. These are Asahi Glass and Nippon Plate Glass. Expansion plans contemplated by other firms in the field will probably not be licensed for the time being, although the prospects are better in glass wool and special glass lines, whose development is considered "urgent" under the wartime economy.

Upon completion of its new bottle plant at Kawasaki near Yokohama, the Tokunaga Glass Co. has begun active sales in the Tokyo-Yokohama district, competing at cut-throat prices with the Dai Nippon Glass Co., subsidiary of Dai Nippon Brewery. This attempt of an outsider to break into the beer brewers' self-contained bottle market is attracting considerable attention.

**Soviet Russia**—Plans* have been announced for the improvement of many Soviet glass factories which hitherto have been operating by primitive methods and obsolete equipment. In the Commissariat of Local Industry, 300 semi-automatic machines manufactured in USSR, 30 imported machines of the same type and 54 glass processing machines have already been installed. The Merefa Glass Works is to be reconstructed and production mechanized by the installation of 10 automatic machines.

Construction of several new glass factories is also reported, two having already been completed. Both were equipped with machinery capable of an annual output of 100,000,000 jars. A new glass factory for the perfume and cosmetics industry is expected to produce 20,000,000 flasks annually by a mechanized process.

**Syria**—The Syrian glass industry has declined considerably due to its old-fashioned manufacturing methods and it is now proposed to set up an up-to-date factory with the assistance of European technicians.

**Turkey**—Under the Turkish Five-Year Plan, a glass factory started operations in 1935 with 300 to 350 workmen. According to reports, there are now 800 to 840 workmen and the number of foreign engineers is said to have been reduced from 75 to 46. The factory covers the entire requirements of the country for bottles for liquors, water, perfumes and medicines and has an annual production of 18,000,000 to 20,000,000 bottles.

*This information is supplied by the Specialties Division of the U. S. Department of Commerce which accepts no responsibility for its accuracy though the information was received from usually responsible sources.

# G-E PERFECTS FLUORESCENT LUMILINE LAMPS

The General Electric Co. has developed new light sources which are said to produce hitherto unobtainable tints of colored light. Called fluorescent lumiline lamps, they give in some cases 120 times the illumination for the current consumed as filament lamps of the same color, with only a fraction of the heat. One of them produces the nearest approach to natural daylight ever achieved by any artificial illuminant.

These lamps were first shown in perfected form at the April 22nd joint meeting of the New York Electrical Society, American Institute of Electrical Engineers and the Illuminating Engineering Society by Ward Harrison, engineering director of General Electric's Incandescent Lamp Department at Nela Park, Cleveland, where they were developed.

Mr. Harrison said that the secrets of the efficiency and color producing qualities of the new lamps are the fluorescent powders compounded and specially heat-treated at the Nela Park laboratories. Activated by ultra-violet and functioning as transformers, the powders absorb the short, invisible ultra-violet rays and re-radiate this energy in those higher wave bands that comprise the color range of the spectrum. Each powder has its own characteristic wave-band with which it responds to the ultra-violet, thus forming its own particular color of emitted light.

"The amount of light produced is governed by the intensity and quantity of the ultra-violet energy absorbed, and the efficiency with which this energy is radiated in the longer wave-bands," Mr. Harrison explained. "For example, one powder will re-radiate the absorbed energy in the short wave-band of the spectrum, forming blue light; another, in the long wave-band of the spectrum, providing red light. Thus by the proper selection and blending of powders, it is possible to produce re-radiation in practically any desired part of the spectrum. This permits the production of lights in hitherto unobtainable pastel tints as well as pure colors."

The individual powders differ in the efficiency with which they convert the ultra-violet energy into visible light. For this reason, the lamps producing the different colors of light vary within fairly wide limits. The green, for example, has been found to be most efficient, producing 60 lumens-per-watt in the 30-watt size. The blue is least efficient (about 20 lumens-per-watt) and the white gives approximately 30 lumens-per-watt.

In comparing the relative efficiencies of the new fluorescent and standard blue-coated tungsten lamps, Mr. Harrison recalled that the latter produces only 3/10's lumens-per-watt, representing an efficiency of less than 1/200th that of the new fluorescent type. This is partly due to the fact that the brilliant tungsten filament emits light made up of all the colors of the spectrum; hence, to obtain a single color, the others must be absorbed. Said Mr. Harrison, "No matter how efficient an incandescent lamp may be in producing its continuous spectrum, it cannot furnish light of a single color at low wattage consumption."

Within the bulb of the new fluorescent lamp is a trace of mercury, a small amount of argon gas at low pressure, and a coating of fluorescent powder. When the

**By a suspended trough system such as the one shown here, General Electric fluorescent lumiline lamps can be used to flood ceilings with rainbow-like hues. The pastel tints are of such a quality that their colorings endure despite light from incandescent lamps elsewhere in the room.**

**In order to coat the inner walls of the new lamps with fluorescent powder, it is first necessary to concoct a creamy solution which is poured into glass tubes. Excess liquid, not adhering to the glass, is removed. A special treatment removes the adhering binder, leaving only a thin coating of powder on the inner walls of the glass tube. Subsequent steps call for the introduction of a trace of mercury, a small amount of argon gas and capping the tube ends with radiotron-type bases.**

**These fluorescent lamps have just come off the exhausting and basing machines. To make this final inspection a score of lamps have been inserted—equipped at each end with metal caps and a pair of base pins—into special-type slotted lock sockets. A switch is then turned on and each lamp emits its particular light.**

current is turned on, the argon serves as a "starter," and in a fraction of a second a feeble blue light with a large component of invisible ultra-violet radiation is generated inside the tube. The ultra-violet radiation strikes the fluorescent coating and is re-radiated in the visible range of the spectrum. Like all electric-discharge light sources, the fluorescent lamps require special transformers or chokes, which serve as valves in controling the flow of electric current. Unlike some other types of mercury-vapor lamps, however, they attain full brilliancy in a few seconds.

Entirely new and interesting possibilities have been opened up for decorative lighting where colored or tinted light is desirable by the development of these fluorescent lamps. The efficiency of the new lamps as compared with tungsten-filament lamps for the same colors gives the former an advantage of at least 1/100 from a lumen-per-watt standpoint. This means, of course, an opening up of many fields of application for the new lamps.

Particularly interesting applications for the daylight and white colors were envisioned by Mr. Harrison. He pointed out that the light from the daylight color is the nearest approach to natural daylight that it has ever been possible to produce directly by an artificial illuminant. The color temperature of this lamp closely approximates 6,500° Kelvin, which is the standard daylight color of the U. S. Bureau of Standards. "Color discrimination and many forms of color matching will be practicable under light from these lamps," said Mr. Harrison.

"The lamp listed as white gives illumination closely approximating regular Mazda lamps. In other words, light from this lamp is rather warm in character and objects apear very similar to their appearances under regular Mazda lamps, with the exception of blues, which are decidedly better than under Mazda lamps.

At present, manufacture of the new fluorescent lamps is being confined to the 15-, 20- and 30-watt sizes.

### J. EARL FRAZIER HONORED

J. Earl Frazier, vice president of Frazier-Simplex, Inc., has received the honorary degree of Doctor of Chemistry from the Academia de Sciencias e Artes, Rio de Janeiro. The same institution also conferred the Scientific Gold Medal of Merit upon Mr. Frazier in recognition of services he had rendered the Pan American nations in connection with the teaching of engineering subjects.

### MAY RUN INTO TARIFF SNAG

A suggestion has been made before the United States Committee for Reciprocity Information, Washington, D. C., that the importation of nepheline syenite into the United States from Canada be limited to a quota of 15,000 tons a year. Considerable concern over this restriction is being felt by the Canadian Nepheline Co., Lakefield, Ont. In an interview with the Toronto *Globe and Mail*, Ralph G. Kilborn, the company's manager, stated that this would mean his company would sell an amount to the United States equal only to that used in a year by one large glass manufacturer.

### W. E. S. TURNER ELECTED TO ROYAL SOCIETY

Professor W. E. S. Turner, Head of the Department of Glass Technology, Sheffield University, has been elected to the Fellowship of the Royal Society. The Royal Society is the premier scientific society in England, dating its origin to the year 1645, and its Fellowship is regarded as a most signal honor.

### WINDOW GLASS PRODUCTION

March production of window glass amounted to 528,302 boxes, comparing with 1,143,357 boxes in 1937. These figures show the industry to have been operating at 32.5 per cent of capacity this year as against 70.5 per cent of capacity during the same period a year ago.

### PLATE GLASS PRODUCTION

The total production of polished plate glass by member companies of the Plate Glass Manufacturers of America in March, 1938, was 3,802,112 sq. ft., as compared to 2,663,838 sq. ft. produced by the same companies in February and 20,742,575 sq. ft. produced in the corresponding month last year. This makes a total of 11,585,129 sq. ft. produced in the first quarter of 1938.

### GLASS CONTAINER PRODUCTION

Production of glass containers for the quarter ending March 31, totaled 9,752,091 gross, a decrease of 19.55 per cent from the corresponding period last year. January production was 3,120,586 gross, February 2,994,502 gross and March 3,637,003 gross, a decrease from the corresponding months in 1937 of 22.75 per cent, 22.87 per cent and 13.41 per cent respectively. 1937 was the banner year in the industry's entire history.

Shipments of glass containers totaled 9,513,551 gross for the quarter, a drop of 21.29 per cent from last year. January shipments totaled 3,004,103 gross, February 2,893,084 gross and March 3,616,364 gross, a decline from last year of 22.59 per cent, 22.72 per cent and 18.95 per cent respectively.

# MELLON INSTITUTE'S FIRST YEAR IN NEW HOME

A year of real achievement in its fine new home has been celebrated by the Mellon Institute of Industrial Research in Pittsburgh, according to the 25th annual report of its director, E. R. Weidlein. The new building* has not only supplied adequate space and equipment and inspired a new enthusiasm on the part of the fellows for their work, but has served as a center for scientific meetings in Pittsburgh.

The auditorium has been used for sessions of the Pittsburgh sections of the American Ceramic Society and the American Chemical Society as well as for meetings of the local chapter of the American Institute of Chemical Engineers and the Allegheny County Medical Society. It has also been used by other organizations for public scientific lectures, by many technical societies for special lectures, and for a comprehensive series of lectures by specialists arranged by fellows of the Institute.

In addition to this important contribution to the scientific community of Pittsburgh, the research programs of the Institute, so important to modern industrial development, have been expanded. During the fiscal year ending March 1, 1938, 72 industrial fellowships, 34 multiple and 38 individual, requiring the services of 142 fellows and 76 assistants, were in operation. Because of their achievements, many of the fellowships have assured their continuation with the result that 37 fellowships have been operating for five years or more. Of this number, 18 have been active for 10 years, eleven have concluded 15 or more years of research and eight fellowships are more than 20 years old. Seven fellowships began operation this year and four new fellowships to start research in the near future have been accepted by the Institute. This work was carried on during the fiscal year 1937-38 at a cost of $1,062,830.

Much of the progress in industrial fellowship research at Mellon Institute cannot, of course, be announced, but Dr. Weidlein's report contains a great deal of interest to the glass and related industries. The establishment of a multiple fellowship by the Pittsburgh Plate Glass Co. in connection with its Central Research and Development Department was fully described in the December, 1937, issue of GLASS INDUSTRY.

### Structural Glass

The entrance of glass into the structural field has brought new problems for investigation. Glass tile and glass block have strains imposed upon them which cannot be analyzed by the commonly accepted formulas for beams or plates. These newer products of glass technology are not of use as individual units, but only as they are built into larger structural units. Problems of bonding cement to glass and of caulking materials and methods must be solved before glass as a structural material can fully occupy the portions of the field where its usefulness is indicated.

The multiple fellowship of Corning Glass Works on technical glass, with R. R. McGregor as senior fellow, has centered its attention upon such problems as cementing and caulking where the chemical approach has appeared to be useful and has collaborated with engineers working on the same problems. A better understanding of the forces at work in glass structures has resulted, together with the development of higher strength and greater reliability of performance. Through the cooperative system of the Institute it has been possible, in addition, to investigate the uses of newer types of glass products in such apparently foreign materials as paper and lacquers. These studies are still in progress.

* The dedication of this building, with illustrations, was presented in detail in the June, 1937, GLASS INDUSTRY.

**Reading room of the library, Mellon Institute of Industrial Research.**

**Refractories**

Since 1917 the American Refractories Institute has sustained a multiple fellowship managed by S. M. Phelps. Recent developments have to do with learning about the properties of insulating fire brick, plastic refractories, cold-set cements and the spalling of silica brick. Insulating refractories are comparatively new products and it is necessary to have tests available in developing various grades for specification work. Test methods formerly used with heavy types of refractory materials are not applicable to this variety.

The most important quality, other than thermal conductivity, is stability at high temperatures and an exhaustive piece of work has been done to evolve a method of judging this property. The procedure consists in testing an 18-inch square panel by heat treating the face for 24 hours at the required temperature. A surface layer of the individual brick, ⅛-inch thick, is accurately measured along the 9-inch dimension before and after the test by means of a brick meter especially developed for the purpose. The percentage linear change thus obtained predicts any alteration in dimension which will take place on the heated face during service under prescribed temperature conditions. It has been found that there is considerably more shrinkage at a given temperature in the presence of a reducing atmosphere. An increase in furnace gas pressures also causes more shrinkage.

**Fine Silica**

The multiple fellowship on mineral products, sponsored by Norman S. Garbisch and headed by G. J. Bair, has evolved a process for preparing an exceedingly fine silica with unique properties. The products of this process include chemically pure silica and silica containing fluxing agents, wetting agents and other substances for specific purposes. The accurate grading of sub-sieve sized particles is an important feature of the development. An experimental plant with a capacity of 40 tons of processed material every 24 hours has been built under fellowship direction. "Garspar," one of the products of this plant, is especially for use in pottery and glass.

**Silicate Fellowship**

"Fluxtite," a new tank block, was introduced during the year by the Laclede-Christy Clay Products Co. and was a research creation of L. C. Hewitt, holder of the silicate fellowship. According to service records, the product is outstanding in the refining end and in bottoms of glass tanks and pitting is practically absent. A noteworthy observation has been that "Fluxtite" block shows very good corrosion resistance in the bridge-wall position adjacent to the tank throat.

**Ceramic Chemicals**

W. J. Baldwin, working for the O. Hommel Co., has had successful results in research on wet-process enamels during the past three years. This fellowship has evolved a new acid-resisting enamel that has been accepted by the enameling trade. Several new opaque and super-opaque enamels have also been introduced. A number of new ground-coat enamels and several improvements in enamel testing are also among the accomplishments. The enameler's enigma, chipping, has been reduced to a minimum by further developmental work on the one-coat, one-fire "Hommelaya" process of vitreous enameling.

**Sulfur Cements**

"TeGul" sulfur cements, evolved by the multiple fellowship of the Texas Gulf Sulphur Co., are being used in the jointing of ceramic products and iron castings. During 1937 these cements were also adopted for employment with aluminum castings, particularly where the latter are to be jointed to porcelain insulators. Sulphur cements were chosen for this use because of their high resistance to mechanical and thermal shock, although it is recognized that the dielectric property of sulphur may be of value.

Also included in a list of industrial fellowships in operation appended to the annual report are the following fellowships: abrasives, food container, glazing, laboratory constructional materials, lead, natural gas, new plastics and optical glass.

**TO BUY WHITALL TATUM COMPANY**

The Armstrong Cork Co., Lancaster, Pa., has entered into an agreement to purchase the Whitall Tatum Co., Millville, N. J., according to H. W. Prentis, Jr., president of Armstrong.

Whitall Tatum Co. is one of the oldest glass container manufacturers in the country, having celebrated a year ago its hundredth anniversary. It manufactures an extensive line of glass containers, and in addition a line of specialties such as graduates, ampoules, hospital goods, insulators, etc. The Closure Division of the Armstrong Cork Co. has become an important factor in the manufacture of metal, plastic and cork closures. The consolidation, therefore, is quite in line with the trend in the glass container industry, begun some years ago, to offer packers a complete packaging service, whereby the customer can procure closure and container from the same source of supply.

Actual acquisition of the property is expected to be consummated June 20, following a meeting of Armstrong stockholders called for June 20 to amend the articles of incorporation. This amendment will permit the issuance of 60,000 new shares of $100 par 4 per cent cumulative convertible preferred, and an increase of 100,000 shares in the authorized common stock. It is stated that 34,500 shares of the proposed new preferred will be used for the purchase of Whitall Tatum Co.

• The Stuyvesant High School, New York, has included glass (lamp) working in its curriculum.

THE SHARP-SCHURTZ COMPANY

CHEMISTS AND CONSULTING ENGINEERS

FOR THE GLASS INDUSTRY

LANCASTER, OHIO U. S. A.

# EQUIPMENT AND SUPPLIES

## THERMAL SHOCK TESTING MACHINE FOR BOTTLES

Testing of bottles by the method of immersing them first in hot water and then in cold, thus developing tensile stresses in the outer wall, has been practiced for a decade or more and has become more general in recent years. With increasing experience it has become apparent that the test may disclose, in bottles, more sources of weakness than one, and is not simply a test for cord as was thought by some experimenters in the early days. It has also been discovered that the conditions of the test should be standardized in some rather unexpected particulars if accurate checking of the plant operation is to be obtained. The latest attempt to meet all the requirements is illustrated in the figure, which shows a front view of an automatic machine developed by Dr. Preston's staff at Butler, Pa., for the Glenshaw Glass Company.

On the left is the hot water bath, copper lined and insulated, heated by two hot water heaters (of which one is seen at the extreme left), the water being forced rapidly and continuously through the heaters by the motor driven pump shown at the lower left corner.

On the right is the cold water tank, of galvanized iron, and not insulated, and in front thereof the drainage rack.

In the center is the control panel, behind which, between the two baths, is an A-frame carrying a counterbalanced crank, from which the basket of bottles is suspended. In the figure the basket is shown at the right, at a level just above the cold water, which is the loading position. The bottles are separated from one another by a grid or partitioning device, which is removable so that other grids may be substituted for other sizes of bottles. A corresponding removable grid sits in the drainage rack.

A quick-acting mesh-work lid clamps over the bottles to prevent them floating when submerged. The grids normally will hold 25, 36 and 49 bottles, respectively, as the size of bottle gets progressively smaller.

The crank (horizontal in the figure) is provided with a parallel link motion, so that the bottles always stand vertical and are immersed in a definite fashion.

Dial thermometers at the top of the control panel indicate the temperatures of the hot and cold baths. They may be replaced by thermostats, so that the bath temperatures are automatically controlled.

Beneath them and centered in the panel is a cam, hinged to the axle of the crank and making contact with three limit switches, to the right of which is the main incoming switch of the power line.

Beneath the central limit switch is the starting button, and across the bottom of the panel are the switch for the pump motor, the magnetic reversing switch for the crank motor, and the time relay.

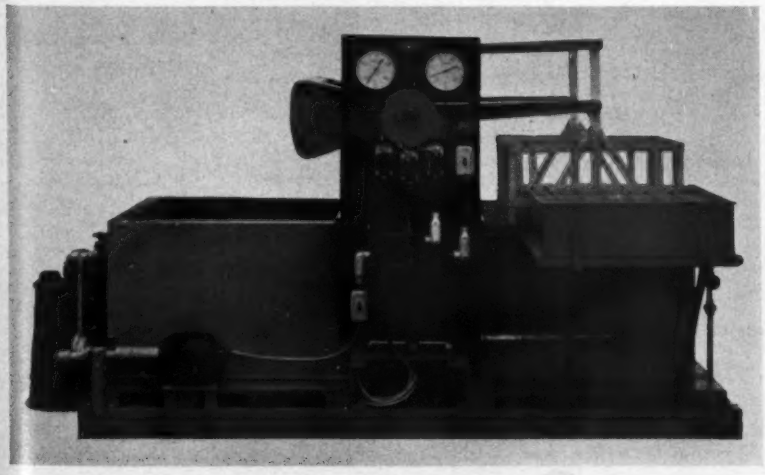
Behind the panel, in the A-frame, is the crank motor and the drive to the crank, the thermometer connections, and so forth.

In the figure the bottles have been loaded into the basket and the bath temperatures adjusted. The lid is now placed over the bottles and the starting button pressed. The operator then goes about any other business he may have, the machine completing the test unattended.

The basket moves over to the left and immerses in the hot water. The crank motor stops and the time switch starts. After 5 minutes, during which time the bottles heat up as much as is practicable in any reasonable length of time, the time switch stops and the crank motor starts in reverse, carrying the bottles in 15 seconds transfer time over to the cold bath and immersing them there. Again the crank motor stops and the time switch starts, and after 30 seconds immersion in the cold water, the bottles are raised once more by the crank motor to the loading position shown in the figure.

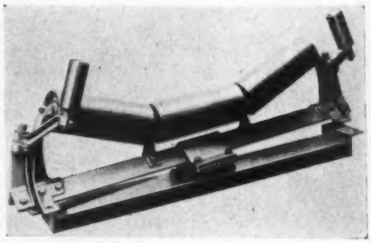
This is the end of the cycle, and nothing further happens until the operator comes to inspect the bottles for breakage.

The machine has been developed as part of the G. C. A. program to improve and standardize testing methods as far as practicable with our present knowledge.



## JEFFREY SELF-ALIGNING BELT IDLER

A new self-aligning idler for automatically training conveyor belts without damaging the belt is announced by Jeffrey Manufacturing Co., Columbus. It consists of a standard anti-friction idler pivotally mounted on a supporting cross member, with guide rolls at each end.

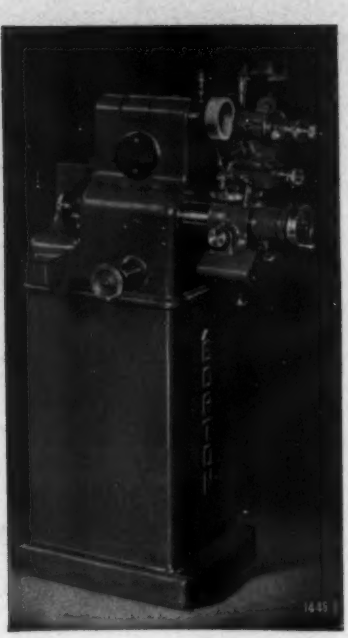


These guide rolls are mounted on pivoted arms that extend at right angles to the idler in the direction from which the belt approaches and are held in place by an easily removed locking pin. By swinging the arms through 180 deg. and putting the lock pin in place on the opposite side, the guides are made ready to train the belt when traveling in the reverse direction. As there is no pressure between the guide rolls and belt, there can be no damage to the edge of the belt. The guide roll moves outwardly the instant the belt touches it, and in so doing swivels the idler sufficiently to cause the belt to return to normal position.

## CUTTER GRINDER FOR DIE AND MOLD CUTTERS

Cutter grinder No. 375-2, a recent addition to the line of George Gorton Machine Co., Racine, Wis., is designed particularly for grinding the single flute cutters, which canot be ground properly on standard types of cutter grinders. It will also grind other types of small cutters, with not over $\frac{5}{8}$-in. shank, used in die and mold cutting and pantograph engraving and profiling work, two- and four-flute cutters and cutters with two, three, or four sides or flats.

The 375-2 grinder is equipped with universal tool head, No. 717-1, and will grind cutters to any desired diameter, taper, shape, or clearance, and with square, conical, or ball nose. An index



dial and plunger is provided for grinding cutters with 1, 2, 3, or 4 slides. There are micrometer dials on all adjustments. Carbide cutters may also be ground in any of the above shapes and sizes on interchangeable diamond-impregnated wheels. Straight cup wheels are furnished for single flute cutter grinding, and flaring cup wheels for multiflute and spiral flute cutters.

Built for the most exacting work, this cutter grinder is completely fitted with ball bearings, all bearings being dust-proof and running in oil. Simple, positive adjustments for wear are provided at vital points.

### IMPROVED FLEXIBLE COUPLING

An improved model of its sprocket-and-chain flexible coupling, known as type RCB, has recently been placed on the market by Link-Belt Co., 301 N. Michigan Ave., Chicago, Ill. A feature of the improved design is the use of a patented divided roller in the chain, the object of which is to prevent scuffing of the rollers and the sprocket teeth in operation. Other improvements include a grease-retaining housing, provision of fittings which permit packing the housing with grease without dismantling the coupling, and a better seal between the coupling halves to prevent leakage of grease. Illustrated booklet No. 1545 gives dimensions, ratings and other data.

### THE DUSTFOE RESPIRATOR

The Dustfoe Respirator, a newly developed respirator bearing U. S. Bureau of Mines approval No. 2115, weighing less than 3¼ ounces and providing protection with comfort under severe working conditions, has recently been placed on the market by the Mine Safety Appliances Company, Braddock, Pittsburgh.

The Dustfoe respirator is said to allow full vision in any direction, without interfering with the wearing of goggles, spectacles, welding helmets or head-coverings of any kind. All metal parts are made of aluminum, are quickly replaced, and may be thoroughly sterilized at any time, including the soft rubber face-cushion.

It is stated by the manufacturer that the new two-element Dustfoe filter will eliminate dust particles as small as one micron (1/25,000 inch) in size, with high efficiency and unnoticeable breathing resistance. Replacement of filters is simple and requires but a few seconds. Low-cost of cellulose filters assures economical maintenance. Bulletin No. CM-1 gives a complete description and illustration of the new respirator.

### CATALOGS RECEIVED

*The C. O. Bartlett & Snow Co.*, Cleveland. New Belt Conveyor Idler Bulletin, No. 80, is a 24-page book that illustrates and describes a new line of belt idlers equipped with Timken bearings. Data published includes weights and prices.

*Bailey Meter Co.*, Cleveland. A 32-page bulletin, entitled "Bailey Boiler Meters," analyzes 7,000 combustion tests made during the last 12 years on all types and sizes of boilers, including a full range of fuels and methods of firing.

*Lewis-Shepard Co.*, Watertown, Mass. Circular No. 232 gives complete data on a new design of floor truck with arc-welded frame, Hyatt roller bearings, and metal, solid rubber or pneumatic tires. Standard capacities from 1,000 to 4,0000 pounds.

*Stearns Magnetic Manufacturing Co.*, Milwaukee. Bulletin No. 92-B covers the line of Class A and Junior Type B spout magnets, furnished with or without automatic shut-off gates.

*The DeVilbiss Company*, Toledo. New catalog "ID" covers complete line of spray painting and finishing equipment, including spray guns, feed tanks and equipment, special containers, air and fluid hose and connections, spray booths and exhaust systems, air compressing outfits.

*The Brown Instrument Co.*, Philadelphia. Folder No. 94-1 illustrates and describes the Pneumatic Remote Transmission System of measurement and control in hazardous atmospheres.

*Willson Products, Inc.*, Reading, Pa., has just issued a new catalog of industrial safety devices. This well illustrated booklet covers the company's complete line of eye, nose, throat and lung protectors. Included are more than 50 types of goggles, a dozen welding handshields, seven U. S. Bureau of Mines approved types of dust respirators, air line respirators, abrasive helmets, etc.

*The Northern Blower Co.*, Cleveland, Ohio. Bulletin No. 500-3 illustrates and describes the "Norblo" Square-Type Air Filter. This filter is constructed for continuous automatic operation and incorporates shaking and air-reversing mechanisms for keeping the filter cloth clean. A table of dimensions, weights and capacities is included.

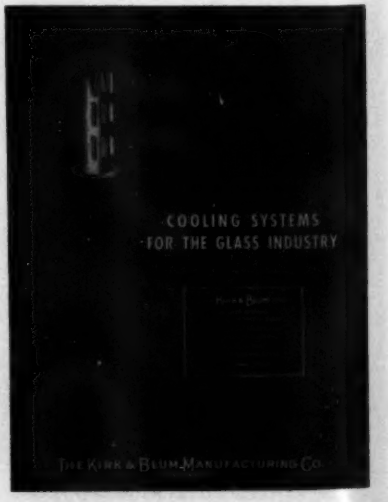
*Bacharach Industrial Instrument Co.*, 7006 Bennett St., Pittsburgh. Optical Pyrometer Bulletin No. 300 is a well-illustrated 8-page booklet which gives much pertinent and interesting data regarding the design, construction and use of optical pyrometers. Leaflet No. 301 illustrates and describes the portable Ardometer for measuring temperature by heat radiation.

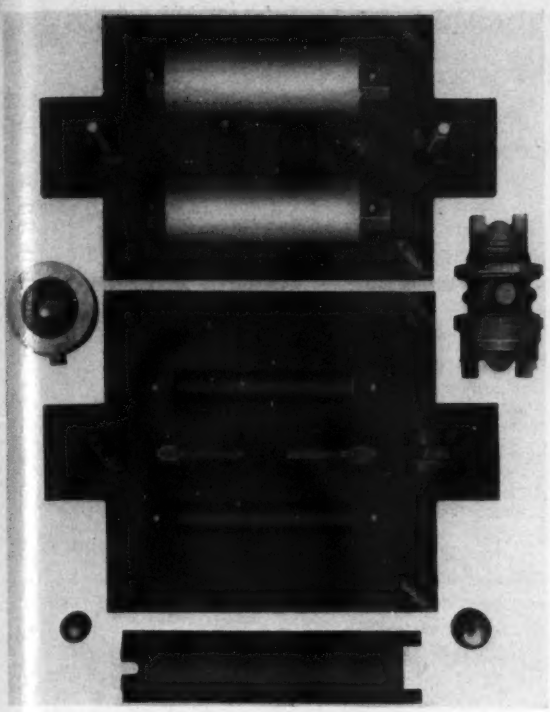
*Ingersoll-Rand Co.*, 11 Broadway, New York. Cameron Two Stage Centrifugal Pumps are illustrated and described in Bulletin No. 7067. Complete specifications and operating characteristics of Class GT pumps are given.

### COOLING SYSTEM BOOKLET

Kirk & Blum Manufacturing Co., Cincinnati, has recently published a beautifully-illustrated, 18-page booklet entitled "Cooling Systems for the Glass Industry." The information given in the book will be of interest to all glass plant engineers and executives, because it describes and illustrates in detail the construction and operation of Kirk & Blum cooling equipment in a number of specific installations. The information given is factual and timely.

Of particular interest is the design of the blower fans used with these systems, said by the manufacturer to have overcome much of the objection to air cooling on account of higher operating costs. The design, construction and operation of the patented cast-aluminum nozzles furnished by this company are also covered in detail with appropriate illustrations. Not the least important is the explanation of means to insure proper cooling under all conditions and the manner in which access to furnace or machine is given for repairs.





## Metal patterns for accuracy, fast delivery and production economy

**Gunite** has four or five times the operating life of ordinary glass mould iron—an important economy. It has just the right hardness and polish—producing lustrous, smooth ware unusually free from defects.

**Gunite** insures substantial savings from lowered cost of replacements, absence of spoiled ware, and fewer shutdowns.

**Gunite** castings are made with all the care and skill acquired through eighty-four years of foundry experience.

Cope and drag metal patterns for machine equipment assuring accuracy, fast delivery and production economy. Send for booklet describing complete line of **Gunite** glasshouse castings—round bar stock, Miller plungers and guide rings, neck ring sticks, bushing stock, press and blow moulds, and metal patterns.

**GUNITE FOUNDRIES CORPORATION**

**ROCKFORD • ILLINOIS**

**Established 1854**

**SOLVAY**

PRODUCTS

## Welcome NEWS For The GLASS MAKER!

**NOW**—a reliable *domestic* source of supply for Potassium Carbonate—with the same density and granulation as SOLVAY *Dense Soda Ash*, thereby eliminating all danger of segregation of the batch.

**SOLVAY DUSTLESS CALCINED**

98-100%

## POTASSIUM CARBONATE

Also Granular Hydrated 83-85%

•

**GROUND CAUSTIC POTASH**

**NEW**—but already setting the same high standard in the Glass Industry as that attained by

**SOLVAY DENSE SODA ASH**

•

**SOLVAY SALES CORPORATION**

*Alkalies and Chemical Products Manufactured by The Solvay Process Company*

**40 RECTOR STREET NEW YORK**

BRANCH SALES OFFICES:

Boston Charlotte Chicago Cincinnati
Cleveland Detroit
New Orleans New York Philadelphia
Pittsburgh St. Louis Syracuse

# CURRENT PRICES OF GLASS-MAKING MATERIALS

**FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS**

## Base Materials

| | | Carlots | Less Carlots |
|---|---|---|---|
| Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh | ton | 43.00 | 46.00 |
| Barium sulphate, in bags | ton | 19.00 | 24.00 |
| Barium sulphate, glassmaker's, carlots, bulk f. o. b. shipping point | ton | 15.00-16.00 | 18.00 |
| Borax ($Na_2B_4O_7 10H_2O$) | lb. | .... | .... |
| Granulated | In bags, lb. | .021 | .026-.0286 |
| Powdered | In bags, lb. | .0235 | .0286-.036 |
| Boric acid ($H_3BO_3$) granulated | In bags, lb. | .0475 | .0531-.0556 |
| Calcium phosphate ($Ca_3(PO_4)_2$) | lb. | .07 | .07¼ |
| Cryolite ($Na_3Al\ F_6$) Natural Greenland (Kryolith) | lb. | .0875 | .0925 |
| Synthetic (Artificial) | lb. | .0875 | .0925 |
| Feldspar— | | | |
| 20 mesh | ton | 11.00-13.25 | |
| 40 mesh | ton | 11.50-13.75 | |
| Granular | ton | 11.75-14.00 | |
| Semi-granular | ton | 11.00-13.25 | |
| L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags | | | |
| Fluorspar ($CaF_2$) domestic, ground, 96-98% (max $SiO_2$, 2½%) | | | |
| Bulk, carloads, f. o. b. mines | ton | 31.50 | .... |
| In bags | ton | 33.10 | 38.00-40.60 |
| Kryolith (see Cryolite) | | | |
| Lead Oxide ($Pb_3O_4$) (red lead) (N. Y.) | lb. | .07 | .... |
| In 5 Ton lots | lb. | .... | .075 |
| Less than 5 Tons | lb. | .... | .08 |
| Lime— | | | |
| Hydrated ($Ca(OH)_2$) (in paper sacks) | ton | 10.50 | .... |
| Burnt (CaO) ground, in bulk | ton | 7.00 | .... |
| Burnt, ground, in paper sacks | ton | 9.00 | .... |
| Burnt, ground, in 280 lb. bbls. | Per bbl. | 2.25 | 2.25 |
| Potassium carbonate— | | | |
| Calcined ($K_2CO_3$) 96-98% | lb. | .065 | .0675 |
| Hydrated 80-85% | lb. | .055 | .0575 |
| Salt cake, glassmakers ($Na_2SO_4$) | ton | 15.50 | 27.00 |
| Soda ash ($Na_2CO_3$) dense, 58%— | | | |
| Bulk | Flat Per 100 lb. | .95 | .... |
| In barrels | Per 100 lb. | 1.35 | .... |
| In bags | Per 100 lb. | 1.10 | .... |
| Sodium nitrate ($NaNO_3$)— | | | |
| Refined (gran.) in bbls. | Per 100 lb. | .... | 2.50-2.90 |
| 95% and 97% | | | |
| Bulk | Per 100 lb. | 1.35 | .... |
| 200 lb. bags | | 1.415 | 1.44 |
| 100 lb. bags | | 1.45 | 1.475 |

## Special Materials

| | | Carlots | Less Carlots |
|---|---|---|---|
| Aluminum hydrate ($Al(OH)_3$) | lb. | .... | .03½ |
| Aluminum oxide ($Al_2O_3$) | lb. | .04 | .05 |
| Antimony oxide ($Sb_2O_3$) | lb. | .12½ | .13 |
| Arsenic trioxide ($As_2O_3$) (dense white) 99% | lb. | .03 | .03½ |
| Barium nitrate ($Ba(NO_3)_2$) | lb. | .... | .07¾ |
| Rutile ($TiO_2$) powdered, 95% | lb. | .11-.12 | .13-.15 |
| Sodium fluosilicate ($Na_2SiF_6$) | lb. | .05½ | .06 |
| Tin Oxide ($SnO_2$) in bbls. | lb. | .... | .47 |
| Zinc Oxide (ZnO) | | | |
| American process, Bags | lb. | .06¾ | .06½ |
| White Seal, 150 lb. bbls. | lb. | .08¾ | .09 |
| Green Seal bags | lb. | .08 | .08¼ |
| Domestic White Seal bags | lb. | .08½ | .08¾ |
| Red Seal, bags | lb. | .07½ | .07¾ |
| Zircon | | | |
| Refined Granular (Milled .01-.02c higher) | | .06½ | .07-.08 |
| Commercial, Gran. (Milled .02¼-.02½ higher) | | .02¾ | .03-.03½ |

## Coloring Materials

| | | Carlots | Less Carlots |
|---|---|---|---|
| Barium selenite ($BaSeO_3$) | lb. | .... | 1.50-1.75 |
| (Commercial, 25% Selenium) | lb. | .... | .90 |
| Cadmium sulphide (CdS) | lb. | .... | 1.10-1.15 |
| Chromite (99% through 200 mesh) | lb. | 37.00 | 40.00 |
| Cerium hydrate | | | |
| 100 lb. drums and 600 lb. barrels | lb. | .... | .60 |
| Chrome Oxide Green, 400 lb. bbls. | lb. | .... | .22-.26 |
| Cobalt oxide ($Co_2O_3$) | | | |
| In bbls. .350 lbs. or more, | lb. | .... | 1.67 |
| Less than 350 lbs., | lb. | .... | 1.77 |
| Copper oxide | | | |
| Red ($Cu_2O$) | lb. | .... | .20½ |
| Black (CuO) | lb. | .... | .15-.17½ |
| Black prepared | lb. | .... | .22 |
| Iron Oxide— | | | |
| Red ($Fe_2O_3$) | lb. | .... | .0425 |
| Black ($Fe_3O_4$) | lb. | .04½ | .... |
| Iron Chromate | lb. | .... | .035-.05 |
| Lead Chromate ($PbCrO_4$) | lb. | .... | .16 |
| Manganese, Black Oxide | | | |
| In Paper bags | ton | 57.00 | 64.50-66.50 |
| In Burlap bags | ton | 65.50 | 67.50-69.50 |
| In Casks | ton | 70.50 | 72.50-74.50 |
| Neodymium oxalate, 50 lb. drums | lb. | .... | 3.50 |
| Nickel oxide ($Ni_2O_3$), black | lb. | .... | .35-.40 |
| Nickel monoxide (NiO), green | lb. | .... | .35-.40 |
| Potassium bichromate ($K_2Cr_2O_7$)— | | | |
| Crystals | lb. | .08¾ | .0925 |
| Powdered | lb. | .... | .0975 |
| Potassium Chromate ($K_2CrO_4$) 100 lb. kegs | lb. | .... | .27 |
| Powder blue | lb. | .... | .2075-.2125 |
| Pyrophyllite, Standard Grade | lb. | 9.00 | 12.00 |
| Rare earth hydrate | | | |
| 100 lb. drums | lb. | .... | .35 |
| 325 lb. barrels | lb. | .... | .30 |
| Selenium (Se) In 100 lb. lots | lb. | .... | 2.00 |
| In lesser quantities | lb. | .... | 2.10 |
| Sodium bichromate ($Na_2Cr_2O_7$) | lb. | .06¾ | .0725 |
| Sodium chromate ($Na_2CrO_4$) Anhydrous | lb. | .08¼ | .08½ |
| Sodium selenite ($Na_2SeO_3$) | lb. | .... | 1.80-2.00 |
| Sodium uranate ($Na_2UO_4$) Orange | lb. | .... | 1.50-1.55 |
| Yellow | lb. | .... | 1.50-1.55 |
| Sulphur (S)— | | | |
| Flowers, in bbls. | Per 100 lb. | 3.35 | 3.70-4.10 |
| Flowers, in bags | Per 100 lb. | 3.00 | 3.35-3.75 |
| Flour, heavy, in 250 lb. bbls. | Per 100 lb. | 2.90 | 3.25-3.65 |
| Uranium oxide ($UO_2$) (black, 96% $U_3O_8$) 100 lb. lots. Black | lb. | .... | 2.25 |
| Yellow orange | lb. | .... | 1.50 |

## Polishing Materials

| | | Carlots | Less Carlots |
|---|---|---|---|
| Emery, Turkish | lb. | .... | .07 |
| Pumice Stone, | | | |
| American Ground Italian FFF, FF, F | lb. | .... | .03 |
| 0, 0½, ½, 1. | lb. | .... | .03¼ |
| Putty Powder | lb. | .... | .38-.42 |
| Rotten Stone | lb. | .... | .03 |
| Rouge, Red | lb. | .... | .14 |
| Black | lb. | .... | .16 |

# BINNEY

MIN-OX

MIN-OX Moulds—improve appearance by assuring:
highest possible lustre
smoothest finish
clear mould pattern impression

MIN-OX Moulds—reduce costs through:
minimum cleaning requirements
practical elimination of fire-finishing
longer mould life

MIN-OX Moulds—increase profits via:
greater sales through improved quality and substantially lowered manufacturing costs.

Write today for full details and case histories.

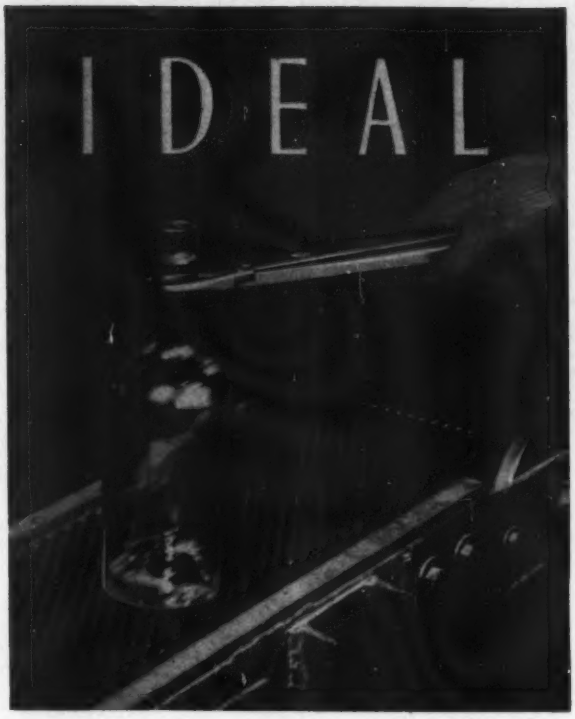
THE BINNEY CASTINGS COMPANY
TOLEDO, OHIO
*originators of alloys for glass molds*

# 1918–1938

Twenty years of service to the manufacturers of Glass Bottles, Jars and Pressed ware has given us the experience to properly take care of your future mould requirements. During these years we have built up one of the most modern and completely equipped shops which enables us to manufacture mould equipment accurately.

❖

**THE TOLEDO MOULD COMPANY**
**1920 CLINTON STREET**
**Toledo, Ohio, U.S.A.**




*for both* **CONVEYING** *and* **ANNEALING!**

Perfect articulation permits smooth travel on a Wissco Conveyor Belt at high speed. Special alloys enable Wissco Lehr Belts to give long life even in elevated temperatures. They absorb a minimum of heat.

**WICKWIRE SPENCER STEEL COMPANY**
**41 EAST 42nd STREET, NEW YORK CITY**
**BUFFALO • WORCESTER • CHICAGO • SAN FRANCISCO**

*Send for this Conveyor Belt Handbook*

**WISSCO**
**CONVEYOR BELTS**

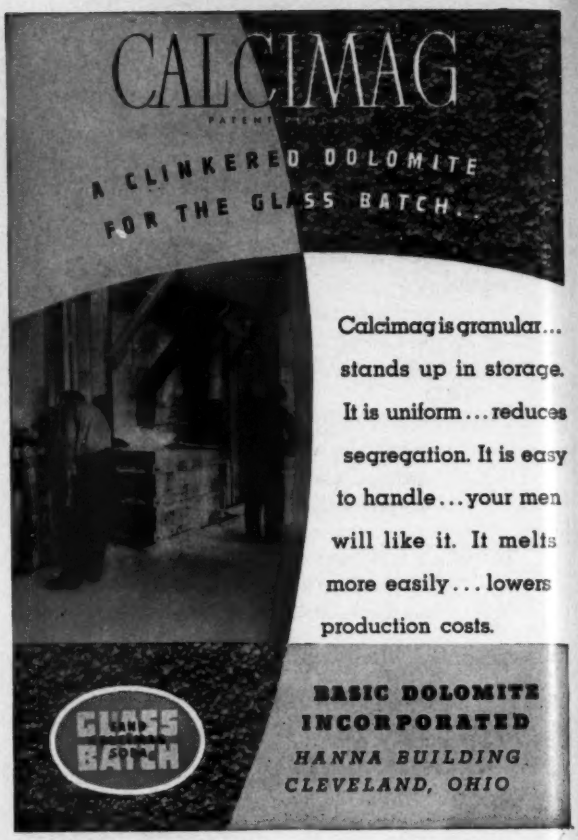
WICKWIRE SPENCER STEEL COMPANY
41 E. 42nd St. New York, N. Y.
Please send me a copy of your new Conveyor Belt Handbook
Name.....
Firm.....
Address.....
City..... State.....

## halve mold costs

In the modern die and mold shop, all duplicates and multiple cavity jobs and making originals from stone or plastic models are given to Gorton Duplicators.

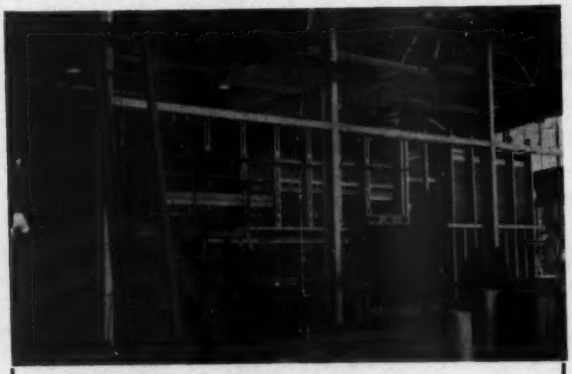
Savings in time and money averaging 50% and the advantage of being able to use semi-skilled men on precision work with Gorton Duplicators are too important to neglect wherever die and mold reproduction is a factor. Send for our bulletin 1319B.

GEORGE GORTON MACHINE CO
502 13TH ST RACINE WIS




Calcimag is granular... stands up in storage. It is uniform... reduces segregation. It is easy to handle... your men will like it. It melts more easily... lowers production costs.

BASIC DOLOMITE INCORPORATED
HANNA BUILDING
CLEVELAND, OHIO



ENGINEERS and CONTRACTORS
to the
GLASS INDUSTRY

Specializing in— TANK FURNACES
POT FURNACES
LEHRS
PRODUCER PLANTS
OIL SYSTEMS
BATCH HANDLING PLANTS
COMPLETE PLANTS

FORTER-TEICHMANN CO.
119 Federal Street Pittsburgh, Pa.
Cable Address "Forter"

THE HOUSE OF HOMMEL
SUPPLIERS OF ALL CERAMIC NEEDS

GLASSMAKERS
Chemicals—Colors
SUPPLIES

A complete line of quality materials
Immediate shipments

THE
O. HOMMEL CO.
Quality First - Since 1891
209 Fourth Avenue Pittsburgh, Pa.
LET OTHERS IMITATE - WE ORIGINATE

Pacific Coast Agents
L. H. BUTCHER CO.
Los Angeles - Salt Lake City - San Francisco - Portland - Seattle

# THE OTTAWA SILICA COMPANY

OTTAWA. ILLINOIS

THREE PLANTS TO SERVE YOU

OPERATING YEAR AROUND

## GLASS SPECIALTIES

Transparent Colored Blown Sheet Glass
Solid Pot Opal Blown Sheet Glass
Flashed Opal Blown Sheet Glass
Colonial Antique Colored Glass
Heat-Ray Resisting (Cool Glass)
"TWIN-RAY" — the scientific illuminating glass.

HOUZEX

L. J. HOUZE
CONVEX GLASS CO.
Point Marion, Pennsylvania
New York Office: 110 West 40th St.
Chicago Office: 1597 Merchandise Mart
"IF IT'S MADE OF GLASS, ASK US FIRST"

DESIGNS
MODELS
MOULDS
MOULD CASTINGS
Quality and Quick Service
....350 EMPLOYEES
OVERMYER MOULD COMPANY
WINCHESTER, IND.

## BOTTLES

FULL AUTOMATIC MACHINE PROCESS

**Whitall Tatum Company**
Manufacturers Since 1836
Philadelphia New York
FACTORIES: MILLVILLE, N. J.

# Laclede-Christy

**Clay Products Co., St. Louis, Mo.**

Where the first test furnace was designed and built the largest of its type exclusively for glass a valuable adjunct to our Mellon Institute Fellowship in developing Tank Blocks of exceptional durability.